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An Archaeological Survey of the Trout Creek–Oregon Canyon Uplands, Harney and Malheur Counties, Oregon

Richard M. Pettigrew
Clayton G. Lebow

Cultural Resource Series No. 2

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major resonsibility for American Indian reservation communities for people who live in Island Territories under U.S. administration.

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AN ARCHAEOLOGICAL SURVEY OF THE TROUT CREEK-OREGON CANYON UPLANDS, HARNEY AND MALHEUR COUNTIES, OREGON

by

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Prepared for

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In partial fulfillment of Contract No. OR952-CT8-3169

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IRI Report No. PNW89-2

FOREWARD

Located just inside the Oregon state boundary from Nevada, the upland setting of the Trout Creek Mountains and Oregon Canyon area have received little formal attention from professional archaeologists. The region is remote and few land disturbing actions have been proposed for the area in the past. Increasing awareness of cultural resources found in the surrounding lowland areas and reports from individuals about artifactual remains in the higher reaches has raised expectations of important values in the region. With recent proposals of concentrated efforts at riparian enhancement projects and other range developments, it was determined advantageous to obtain a regional perspective of the archaeological record prior to considering individual project proposals. The project was funded by the Vale District Office. The objective of the survey is to better establish a historic context for the area which would benefit individual site evaluations, and also to allow increased sophistication in determining inventory needs for proposed project areas.

Richard C. Hanes
Series Editor

Front cover: Canyon of Cottonwood Creek, high in the Oregon Canyon Mountains.

Back cover: Junction of Whitehorse Creek (far) and Cottonwood Creek (near) canyons, in the Oregon Canyon Mountains.

ABSTRACT

This report presents the results of archaeological investigations by INFOTEC Research, Inc. (IRI), under contract with the U. S. Department of the Interior, Bureau of Land Management (BLM), in the Trout Creek-Oregon Canyon uplands (TCOCU) of Harney and Malheur counties, in extreme southeastern Oregon. The work included environmental analysis through a computerized geographic database, archaeological survey of 5000 acres (1.7%, selected randomly) of the 287,000-acre project area, compilation and analysis of survey results focusing on the association of cultural and environmental variables, and generation of a predictive model of cultural resources distribution.

The survey recorded 78 archaeological sites, including 57 lithic scatters, 13 rock features (mostly rock cairns), six rockshelters, and two obsidian sources. The rock features probably are historic sites, while the remainder are all prehistoric. The six rockshelters are intact and unvandalized; many more such sites likely exist in the TCOCU.

Prehistoric activity apparently revolved around hunting and raw material procurement; only slight evidence of plant food collection was found. Collected projectile points indicate most intense human use between 4000 and 2000 B.P. Archaeological sites show distinct locational tendencies, and are especially concentrated on the high ridges and near lowland streams. A high correlation was calculated between predicted land use intensity (I7) of project quadrats and key measures of prehistoric activity.

For management purposes, this report presents concrete predictions of cultural resources distribution in the project area. Most of the cultural resources appear to exist on 25% of the land area. The report concludes with a set of management recommendations.

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EXECUTIVE SUMMARY

In September, 1988, the BLM contracted with INFOTEC Research, Inc., to carry out a systematic archaeological survey of a representative sample of the Trout Creek-Oregon Canyon Uplands (TCOCU) area in extreme southeastern Oregon to investigate distributional patterns of archaeological sites and materials. This research was to be done in order to form the basis for proactive management of archaeological sites and the development of a regional research design for the archaeology of southeastern Oregon, vast tracts of which are BLM holdings. Further, it was believed that the TCOCU contained an unusual concentration of prehistoric sites, though previous surveys there had been sporadic and incompletely recorded. Certain kinds of sites, such as hunting blinds, rock art, and burials, had not been recorded. Caves and rockshelters, which sometimes contain scientifically valuable perishable artifacts as well as highly useful layered deposits but which are under intense pressure from vandals, were known to exist, but their numbers and degree of preservation were unknown. Extremely large streamside sites, possibly containing buried layers of cultural debris, had been found, but it was unclear whether these sites were exceptional or commonplace. A prehistorically used stone material called Whitehorse obsidian was known to exist in the area, but the location of its source or sources was not recorded. In view of the potential conflicts, then, between the cultural resources present in the area and future developments or management plans relating to other resources, an archaeological survey to assess the frequency and locational tendencies of cultural resource sites was deemed a prudent measure.

The first step in the 1988 archaeological survey was a meeting on September 27 between the authors and Beth Walton, BLM's Vale District Archaeologist, at the Vale District office. On September 27 and 28, the authors conducted a preliminary drive-through reconnaissance of the project area to assess the roads and potential camping locations, and to develop greater familiarity with the locality before final fieldwork preparations. During the week of October 3-7, the authors used data from both BLM and U. S. Geological Survey (USGS) maps to compile a computerized geographic database, encoded on a dBASE III PLUS computer file, for the project area. This database includes data on key environmental variables for each of 1,889 quarter-sections containing BLM property within the 287,000-acre project area. Among the variables encoded are basic locational data, the amount of BLM land within each quarter-section quadrat, elevation, drainage district, length of permanent stream, length of main-stem intermittent stream, length of ridge line, length of rimrock, number of springs, slope characteristics, and the predicted intensity (I) of prehistoric land use. The last variable (I) was defined and computed on the basis of a complex formula, and was a function of environmental variables weighted according to intuitive assumptions. Predicted land use intensity was to be tested on the basis of newly acquired as well as already recorded survey data. A copy of the database on computer disk was provided to the Vale District archaeologist shortly after it was finished.

Since the project scope of work limited the survey to only 5,000 acres

(1.7% of the project area), selection of 36 quarter-section (160-acre) quadrats for field inspection was a task taken very seriously, since the sample was to represent the entire project area and was also intended to promote the discovery of a sizeable number of archaeological sites. To accomplish these goals, the project area was divided, or stratified, into 12 zones on the basis of elevation and drainage district, and survey quadrats drawn separately from each to assure even coverage of the project area. Further, all quadrats were classed as either "high probability" or "low probability" parcels as determined from the predicted land use intensity (I), and quadrat selection was biased in favor of high probability (two "high" quadrats for each "low" quadrat) to maximize the discovery of archaeological sites.

The field survey proceeded in three separate sessions conducted in October and November, 1988. Each session was reported in a short letter report to Vale District Archaeologist. Field inspection involved the use of 30 m transect intervals (the distance between walked paths), and a method of data recordation whereby counts of cultural items were logged for each 30 m segment of each transect. With some exceptions, localities containing 10 or more cultural items (usually stone flakes from the manufacture of flaked stone tools) within a 30 m transect interval were labeled as archaeological sites. Localities with rock cairns or other cultural features also were labeled as sites. The only items picked up from the surface were projectile points, useful for estimating the ages of sites because of their various styles.

We found that the geographic database greatly facilitated analyses and tabulations of project area information. We learned that, as one proceeds from the lower to the higher elevations, intermittent streams become much less common, permanent streams tend to increase slightly, and rimrock, ridgeline and springs increase substantially. A major exception in the north drainage is a decline of rimrock at the higher elevations, owing to the unique physical characteristics of the tilted fault block. Variability in elevation within the surveyed quadrats is extreme, ranging from 60 to 1090 feet. This variability within quadrats varies systematically by elevational interval, from 143.3 feet for the 4000-5000 foot interval to 544.5 feet for the 6000-7000 foot interval. Rimrock is most common for the 6000-7000 foot interval, and least common below 5000 feet. Sources of permanent water are present in surveyed quadrats much more commonly at the higher than at the lower elevations. Naturally occurring obsidian is present throughout the project area, but is much more often seen at the higher than at the lower elevations. As it turns out, Whitehorse obsidian has many more than a single or even several distinct sources, but is found in a multitude of locations in the TCOCU.

Seventy-eight (78) archaeological sites were recorded by the survey, of which 57 (73%) are lithic scatters (concentrations of flaked stone debris on the surface), 13 (17%) are rock features (mostly rock cairns), six (8%) are rockshelters, and two (2%) are obsidian sources (lithic scatters associated with obvious concentrations of sizeable obsidian nodules). The rock features most likely are historic sites, while the remainder are all prehistoric. Lithic scatters range in area from 9 to 54,000 m^2, and range in density from

10 to 1000 specimens per 100 m². Fifty-three (93%) of the lithic scatters are mostly obsidian, while three are primarily cryptocrystalline silica (CCS), one is of basalt, and one site has equivalent amounts of obsidian and basalt. Most tools seen were projectile points (arrowheads or dart points) or similar tools flaked on both faces. Most lithic scatters (38, or 67%) are on deflated surfaces, and appear to have no buried deposits. Two lithic scatters are on streamside benches and probably contain buried deposits.

All six rockshelters appear well preserved and unvandalized, and all probably have buried deposits of cultural debris (such as stone tools, waste flakes from stone tool manufacture, and perishable organic items such as basketry and matting). At one rockshelter, perishable items were found on the surface, and as a group these sites have a wider variety of artifacts and charred animal bone fragments, suggesting they were used as base camps for prehistoric hunters. Evidence for plant food collecting in the project area is slight, amounting to a single mortar found in a rockshelter.

The highest densities of stone flakes occurred at the two sites classed as obsidian sources, up to 5000 items per 100 m² at one and 200 items per 100 m² at the other. These two sites also had some of the greatest surface areas, 54,000 m² and 1800 m², respectively.

Archaeological sites exhibited some distinct locational tendencies. Rock features, as might have been predicted, cluster heavily in the south drainage area, where mining activity has been greatest. Lithic scatter sites are twice as common above 7000 feet than at lower elevations. Distance to water increases with elevation for lithic scatters, but decreases for rockshelters. Ridgetops by far are the favored locations of sites. All rockshelters were found at the base of rimrock, where no lithic scatters were located. Five of the six rockshelters occurred adjacent to major ridges and overlooking steep canyons.

Numbers of archaeological sites and other measures of cultural activity varied greatly from quadrat to quadrat. Many quadrats had no sites, but one had 13. For quadrats with sites, total site area varied from 33 to 120,295 m². Counts of stone flakes ranged from 1 to 32,981 items. Stone flakes themselves varied widely in basic technological characteristics, indicating variability in the precise tasks carried out at flake scatter sites.

The collection of typologically classifiable projectile points from this survey amounts to 54 specimens, the most numerous of which are of the Gatecliff series (15, or 27.8%), considered to be most common between 4000 and 3000 B.P. (years before present), and the Elko series (12, or 22.2%), thought to date mostly between 3500 and 1500 B.P. Of the types most common before 2000 B.P. (generally the larger points), two-thirds are made of Whitehorse obsidian, but those types dating after 2000 B.P. are more often made of CCS and other types of obsidian.

Data analysis focused particularly on testing the reliability of the predicted land use intensity (I), as measured by recorded data such as counts of sites, total site area, and numbers of cultural items found within surveyed quadrats. The original formula predicting land use intensity generated numbers that correlated significantly though modestly (r=.44) with the count of prehistoric items (considered the most reliable measure of actual land use). By modification of the form and content of the predictive formula and the addition of elevation as a key environmental variable, we were able to raise the correlation substantially (r=.73). By doing so we learned that the length of ridgeline within a quadrat is by far the most important variable influencing the amount of prehistoric activity at the higher elevations, though the length of permanent stream is still of greatest importance at the lower elevations.

The predictive capability of the revised land-use intensity (I7) formula was found to be essentially nil when measured against data collected by earlier researchers (Hattori 1980; Minor 1980) who surveyed limited portions of the southern drainage area. This finding appears to result from the small areas covered by those surveys, the association of the surveyed areas with toolstone sources, and important differences in the way data from those surveys were recorded. Previously collected data do not provide a good testing ground for the predictive formula created for the 1988 TCOCU project.

The collected projectile points indicate little use of the project area prior to 7000 B.P., a small increase in intensity between 7000 and 4000 B.P., a major peak in land use between 4000 and 2000 B.P. with some emphasis on the first half of that interval, and a notable decline in intensity after 2000 B.P. This pattern of change supports the land-use model proposed by Pettigrew (1984), which is modified somewhat on the basis of the regional review conducted for this project.

Human use of the TCOCU appears to have been dominated by hunting and the collection of toolstone, to the near exclusion of plant food collecting, at least as registered archaeologically. Thus, prehistoric sites probably reflect one or more of a variety of possible functions, from single use (and possibly single episode) open sites to rockshelter base camps where a great variety of tasks were carried out. The reduced use of Whitehorse obsidian and the correspondingly greater use of other obsidian and CCS among the projectile points after 2000 B.P. fits with data from Dirty Shame Rockshelter in the Owyhee Uplands as well as from areas of south-central Oregon and northeastern California, and may reflect a reduced demand for large flakes and large cores (stone chunks from which flakes were struck) following the introduction of the bow-and-arrow with its smaller points.

The proposed land-use model appears to apply mostly to the northern Great Basin, especially from the TCOCU to Steens Mountain, but is supported also in general terms by data from the Owyhee Uplands of southeastern Oregon and southwestern Idaho. The Owyhee Uplands, however, differ in important ways geographically from the Basin and Range Province, and thus can be expected to differ also with regard to cultural adaptation. For example, some evidence suggests that land-use intensity increased in the Owyhee Uplands after 2000 B.P., when it appears to have decreased in the Steens-TCOCU vicinity.

The TCOCU has contributed important new approaches and information to the cultural study of the Oregon-Idaho-Nevada border region. New approaches include new and successful field methods, the use of the computerized geographic database, and the generation of a testable predictive model for the location of archaeological sites. Among the new information are the delineation of site locational patterns, the discovery that possibly substantial numbers of intact caves and rockshelters still exist in the TCOCU, and clarification of the distribution of Whitehorse obsidian, which has been shown to be widespread in the project area.

This project also has contributed new interpretations of prehistory, a noteworthy one being the support for and revision of the evolutionary model of prehistoric land use originally proposed by Pettigrew (1984). Other interpretive contributions are a new review of regional projectile point chronology and a review of the archaeology of the Steens Mountain-Alvord Basin region. Further, the project has helped highlight possibly important differences between the Steens-TCOCU area and the Owyhee Uplands in land-use intensity following 2000 B.P.

The authors carried data analysis one step beyond purely research concerns in order to provide information more directly useful for management. Using the revised formula for predicted prehistoric land-use intensity (I7), all 1889 quarter-section quadrats in the project area were assigned values for I7. On the basis of statistical analysis associating I7 levels with counts of prehistoric items and prehistoric sites in the surveyed area, the authors calculated predictions of those variables for all project area quadrats. For the project area as a whole, it is estimated that complete survey coverage using the described field methods would record somewhere between 2,500,000 and 75,000,000 prehistoric items (including between 2,600 and 80,000 classifiable projectile points), and between 3,800 and 5,200 prehistoric sites (including 175 to 480 intact rockshelter sites). Analysis of the distribution of cultural items and sites suggests further that 98% or more of the cultural items and 70 to 78% of the prehistoric sites are concentrated on 25% of the land area (in those quadrats where I7 ≥ 4.310). As an aid to agency management of cultural resources in the TCOCU, the report includes Figure 6.1, a project area map showing all quadrats coded into four groups (quartiles) on the basis of their I7 values.

The generalizations made about the magnitude and distribution of cultural resources in the project area, though based on the best data available, are tentative. The predicted land-use intensity formula was modified on the basis of the data collected by this survey, and thus cannot be tested by use of the same data. Additional survey would be needed to validate the predictions made here. Thus, it would be unwise at present to rely excessively on the results of this project for management purposes. Nevertheless, it appears that management effort would be wisely spent if largely concentrated in that 25% of the project area thought to contain the bulk of the cultural resources.

The research value of the cultural resources of the TCOCU is great, and should be considered in making management decision. Chronology may be addressed with reference to the large numbers of classifiable projectile points available in the area, and to streamside and rockshelter sites with datable stratigraphic layers in association with prehistoric cultural deposits. Questions concerning human land-use patterns can be researched by additional problem-oriented archaeological survey, in conjunction with data recovery from key sites or areas to analyze site function and chronology. Prehistoric trade patterns can be investigated through sourcing of obsidian types to measure the directions and amounts of regional obsidian exchange. Investigation of methodology can generate progress through further tests of the applicability of the geographic database and the reliability of the predictive model presented in this report, and assessment of the representativeness of the 1.7% sample.

This report concludes with 15 recommendations relating to research and management, and suggested to further the stewardship goals of the BLM in the context of what has been learned from the 1988 TCOCU survey. Among the more important recommendations are the following: an additional survey to test the reliability of the 1988 survey results; special inventory methods for rockshelter sites; systematic survey of nearby lowland areas such as the Coyote Lake Basin; a program or set of standards for the collection and analysis of data from lithic scatter sites; a data recovery policy for highly threatened sites such as rockshelters and streamside sites; obsidian studies (both sourcing and obsidian hydration measurement), particularly as a relatively inexpensive method of dating artifacts and sites; investigation of the practical uses of computerized geographic information systems (GIS) for the management of archaeological and other resources; a study of the geology of toolstone sources, as a way of improving their presently poor locational predictability, which today hinders our ability to predict the locations of archaeological sites; and the use of innovative enforcement measures, such as through cooperation with local ranchers or by use of sophisticated electronic devices, to slow the destruction by vandals of the cultural resource base.

ACKNOWLEDGEMENTS

This study could not have been completed without the assistance of numerous individuals. It is our pleasure to acknowledge the efforts of these people, and to offer our thanks.

We thank Richard Hanes (in Portland) and Beth Walton (in Vale) of the Bureau of Land Management for their advice and input, and for patiently answering our questions. Several individuals in the project vicinity were instrumental to our ability to complete the fieldwork. When the weather deteriorated in late October and November, Jock and Karen Echave provided accommodations at the Oregon Canyon Ranch, and Brent Lay (Manager of the Whitehorse Ranch) let us stay at Sweeney Ranch, thus providing a giant lift to the crew's morale. Dale Anderson of McDermitt was kind enough to provide mechanical assistance on a weekend (and one evening) when one of our pickups broke down.

The crew on this project were faced with extremely rugged terrain and often-adverse weather conditions, but still performed admirably. We thank Charles Armitage, Gary Bowyer, David Conca, Fred Crisson, Cynthia DeFries, Erin Fleming, Peter Kiigemagi, and Matt Zweifel for their assistance. We were aided in the lab by Gary Bowyer, who, along with Thad Van Bueren, also worked on the graphics for this report.

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1. INTRODUCTION

The Bureau of Land Management (BLM) originated this project to inventory cultural resources in the Trout Creek-Oregon Canyon uplands (TCOCU) in order to generate data useful as a basis for pro-active management of archaeological sites, and the development of a regional research design for the archaeology of southeastern Oregon. Although many project-related, and usually small, archaeological surveys had been undertaken in the TCOCU vicinity, the existing data were very uneven in quality, completeness, and location, and thus were of limited use in assessing either patterns of human land use or the distribution of cultural resource sites.

Even so, it was clear from available information that this upland area was particularly attractive to prehistoric people. The abundance of cultural sites and debris there was considered to be among the greatest of comparable localities in the large area of Malheur County. Among the factors considered responsible for this condition were the presence of the widely used Whitehorse obsidian (for which the location of the specific source was not known) and the unusual concentration of permanent streams and springs surrounded by more arid country.

Despite the apparently intense prehistoric use of the area, however, certain kinds of sites, including hunting blinds, rock art, and burials, had not been recorded. Furthermore, huge amounts of unexplored rimrock allowed the possibility that rare undefiled caves and rockshelters could be found. Such shelters are of great scientific value, but are threatened more than other site types, and thus may be in greater need of inventory and protection.

With these understandings and concerns in mind, the BLM contracted with INFOTEC Research, Inc. (IRI), to undertake a systematic investigation of the TCOCU area to determine patterns of cultural resources distribution and environmental relationships, and indirectly to test ideas about patterns of human land use. This investigation was to involve an archaeological survey of previously uninventoried areas, as well as review and analysis of existing data both from within the project locality and from adjacent districts (especially the Steens Mountain-Alvord Desert region to the west and the Owyhee Uplands to the east).

Following the contract award on September 21, 1988, the authors met with Beth Walton, BLM's Vale District Archaeologist, at the Vale District office on September 27 for a pre-work conference. Following the conference, on September 27 and 28, the authors conducted a preliminary drive-through reconnaissance of the project area with the object of assessing the roads and potential camping locations, and to develop greater familiarity with the specific locality prior to final preparations for fieldwork.

Upon returning to Eugene, during the week of October 3-7, the authors, using data from both BLM and U. S. Geological Survey (USGS) maps, compiled a geographic database, encoded on a dBASE III PLUS computer file, for the project area. This database includes all 1889 quarter-sections containing

BLM property located within the project limits, and encompasses some 287,000 acres. Data fields for the database consist of basic locational data, the amount of BLM land within each quarter-section quadrat, and key environmental data considered important factors influencing the intensity of prehistoric land use. Predicted intensity of land use itself is one of the fields, defined and computed on the basis of a complex formula, and a function of environmental variables weighted according to intuitive assumptions. The predicted land-use intensity was to be tested on the basis of newly acquired as well as already recorded survey data. A copy of the database on computer disk was provided to Beth Walton within days after it was finished.

Upon the completion of the geographic database, IRI selected survey quadrats for field inspection. The project scope-of-work called for the coverage of 5000 acres, which we divided into quarter-section (160 acre) quadrats. The authors selected quadrats randomly within sampling strata defined on the basis of elevation and drainage area, but biased the selections systematically to favor predicted high land-use intensity as opposed to low intensity parcels. Though biased in this way to favor the discovery of cultural resources, the sample included a substantial proportion of units considered unlikely to contain prehistoric sites, and thus retained the potential for testing preconceptions about cultural debris distribution and land-use patterns.

The field survey proceeded in three parts: October 13-17, October 25-November 3, and November 9-15, 1988. Clayton Lebow was present for all three sessions, directing the first and the last; Richard Pettigrew was present for only the second, which he directed. Each field session resulted in a short letter report of findings to Beth Walton.

Writing of the project report began immediately following the second field session. Laboratory processing of collected artifacts, computer encoding of site forms, placement of data on project area maps, and analysis of results occurred mostly following the completion of the field survey.

The artifacts collected during the survey, as well as the field records, site forms, and the geographic database are to be curated by the BLM, Vale District.

2. THE PROJECT AREA

The project area, encompassing parts of the Trout Creek Mountains and all of the Oregon Canyon Mountains, is located in southeastern Oregon just north of the Nevada state line and west of the town of McDermitt (Figure 2.1), and includes parts of both Malheur and Harney counties.

The original definition of the project area included all BLM land west of U. S. Highway 95 (the Idaho-Oregon-Nevada Highway), south of the county road to Whitehorse Ranch and Fields, north of the Oregon-Nevada border, and east of the BLM Vale District-Burns District boundary (close to the Malheur County-Harney County line) (Figure 2.2). Consideration of the project goals and funding limitations led IRI to restrict the project area still further. The project area boundary as adopted follows the Oregon-Nevada border through Range 41 East, then proceeds northward along the eastern edge of Range 41 East through Township 39 South. The line then proceeds westward along the northern edge of Township 39 South through Range 41 East, then northward along the eastern edge of Range 40 East through Township 37 South (as it is defined west of Range 41 East). The project boundary then moves westward along the northern edge of Township 37 South to the county road leading to Whitehorse Ranch and Fields, then follows that road southwestward through Range 38 East to the western edge of Range 38 East. The boundary follows that line southward to the drainage divide between Willow Creek and Trout Creek (generally marked by a primitive road on the crest), then proceeds generally southward on that divide to the Oregon-Nevada border (the starting point). A very slight modification to the southern boundary was made when it was discovered that only the Payne Creek USGS 7.5 minute quadrangle map actually terminates at the state line. The other USGS maps in the 7.5 minute series that cover the southern margin of the project area (The V, Chicken Spring, Bretz Mine, and Boghole Spring), stop just short (by about 0.1 mile or 160 m) of the state border, leaving a narrow strip of Oregon to be covered by the next row of maps to the south. For practical purposes, then, the southern project area boundary follows the southern margin of these USGS 7.5 minute quadrangle maps. It also should be noted that, along its western margin, the IRI project area includes portions of Harney County and the Burns BLM District.

The project area so adopted for the most part represents a subset (though a large proportion) of the larger area originally defined by the BLM, for two major reasons. First, it was desirable to delimit the project area as much as possible in order to maximize the representativeness of the survey sample. The larger the project area, the less representative a survey sample of any fixed size. Second, areas were excluded that have a character notably different from the upland zone of primary concern. Blue Mountain, in the northeastern corner of the larger area, is an isolated, lower, and relatively small upland zone without a notable concentration of permanent water. The broad valley of Oregon Canyon Creek is a distinct lowland zone that would not contribute to the study of upland land use. Similarly, the northward-sloping lowlands just north of the IRI project area limits possibly should be investigated at some time, but are not integral to the study of upland land use, since substantial lowland areas (below 5000 feet) are included in the

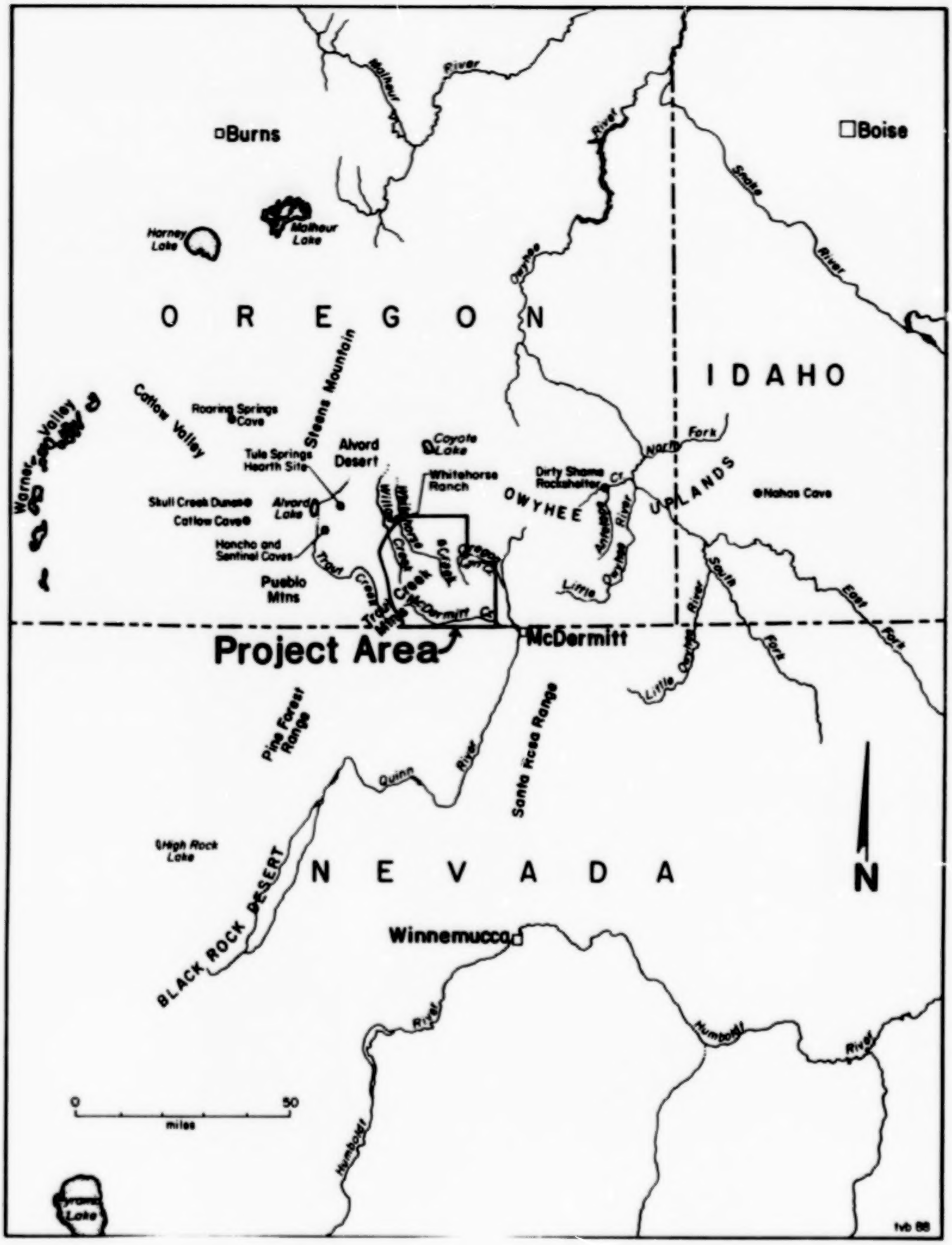

Figure 2.1. Map of the Oregon-Idaho-Nevada Border Region, Showing the TCOCU Project Area.

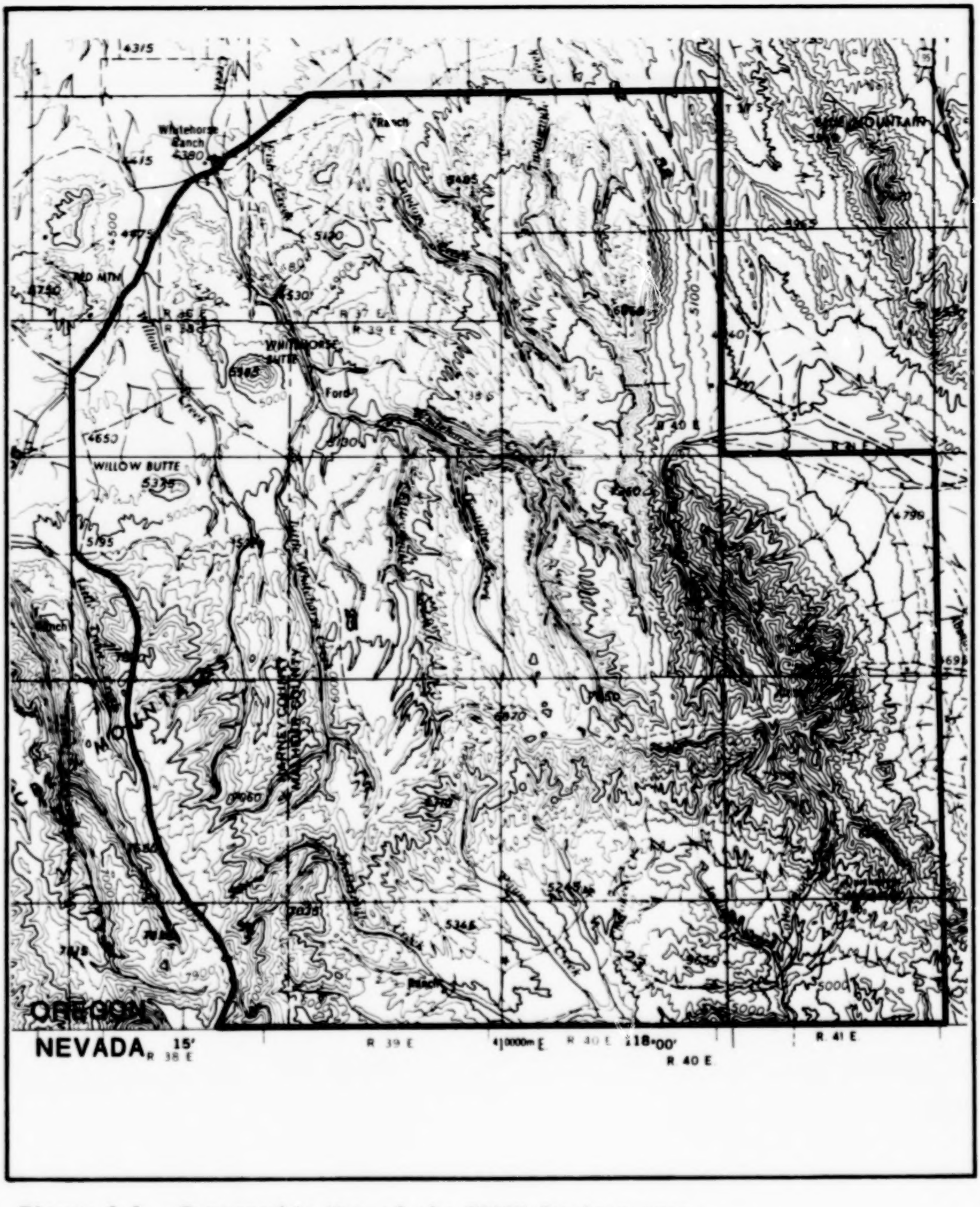

Figure 2.2. Topographic Map of the TCOCU Project Area.
Based on Adel and Jordan Valley USGS quadrangle maps, scale 1:250,000.

finally adopted project area on all margins except the southwestern quadrant.

The upland zone largely encompassed by the project area often is called simply the "Trout Creek Mountains," but in fact contains two distinct mountain ranges. The southwestern border of the project area is the crest of the Trout Creek Mountains proper, which appear to be of volcanic origin and rise to an elevation of 8506 feet just south of the Oregon-Nevada line. These mountains are drained by Trout Creek and its tributaries on the west side, by Willow Creek and Whitehorse Creek and their tributaries on the northeast side, and by McDermitt Creek and its tributaries on the southeast side. Trout Creek empties into Alvord Lake to the west, Willow and Whitehorse creeks flow in the direction of Coyote Lake to the north, and McDermitt Creek is part of the Quinn River drainage system, which flows into the Black Rock Desert in Nevada.

The second mountain range, the Oregon Canyon Mountains, occupies most of the eastern two-thirds of the project area, and is a tilted fault block similar to those more commonly known in the northern Great Basin, such as Steens Mountain, Hart Mountain, Abert Rim, and Winter Rim. The block, generally flat-topped, slopes to the northwest, so that its highest elevation, 8027 feet, is in the southeastern quadrant, and most of the area is drained to the northwest by Whitehorse Creek, Antelope Creek, Twelvemile Creek, and other streams that empty in the direction of Coyote Lake. These streams and their tributaries have cut very impressive canyons into the fault block. The deepest of these canyons, with a depth of about 1500 feet, is Oregon Canyon, in the southeastern and highest part of the range and drained by Oregon Canyon Creek, which, together with McDermitt Creek, forms the headwaters of the Quinn River. The eastern scarp of the Oregon Canyon Mountains is also very impressive, rising to a height of 3000 feet above the valley of Oregon Canyon Creek below. The southern slope of the fault block is not as precipitous, but is still quite steep near the crest, dropping to more gently sloping, hilly terrain to the south. The Oregon Canyon Mountains join the Trout Creek Mountains proper in the southwestern quadrant of the project area, where the southern ridge line of the former range merges with the uplifted terrain of the latter, at the headwaters of Little Whitehorse and McDermitt creeks. Here is the location of a primitive road that crosses the lowest (about 6500 feet) pass between the two mountain ranges to allow travel from the south to the north side of the upland zone.

Volcanic features and formations largely dominate the local geology. Not only do the Trout Creek Mountains have a volcanic origin, but Whitehorse Butte and Willow Butte, rising abruptly from generally level terrain in the northwestern quadrant of the project area, appear to be volcanic cinder cones. The common rimrock is a rhyolite representing late Miocene (ca. 13 million years ago) lava extrusions (Baldwin 1981; Boreson et al. 1979:5-6), subsequently uplifted, tilted, and dissected. The southern portion of the project area, south of the Oregon Canyon Mountains, is the northern part of McDermitt Caldera, formed by a collapse during the Miocene at about 17 million years ago and then filled with tuffaceous lacustral sediments (Hattori 1980:5) that contrast strongly with the rhyolitic beds so common elsewhere in the project area.

Relief within the project area is so marked as to greatly constrain travel routes. Within the upland area, primitive roads and trails are confined to the canyon bottoms and the flat ridges above the canyon rimrock. Only occasional connections exist between the ridgetop and canyon bottom networks, owing to the steep canyon walls. These constraints do not apply in the low elevations of the northwestern quadrant and the eastern and southern margins of the project area, where slopes are much more moderate.

Recent deposition, of a kind that may have buried archaeological sites, is notable only in specific locales. Most of the project area contains quite ancient surfaces, deflated to varying degrees. Exceptions exist along the lower reaches of permanent streams, where the canyons, which at the upper elevations (generally above 5000 feet) have very narrow bottoms, open up and possess gentler gradients, allowing the formation of alluvial terraces with fine-grained sediments. Such is particularly the case for the lower reaches of Willow and Whitehorse creeks in the northwestern quadrant, and McDermitt Creek along the southern project boundary. Fine-grained alluvial sediments tend to occur also at springs, particularly those on low to moderate slopes. Aeolian sediments are possible on sheltered surfaces (especially on the leeward side) of flat-topped ridges, and colluvial deposits exist at the bottoms of slopes throughout the project area. Finally, fine- as well as coarse-grained sediments can occur in caves and rockshelters, where cultural deposits can be preserved remarkably intact. Except in these areas of recent deposition, cultural debris dropped on the surface should either have remained in place or have been transported down slope by erosional processes. The oldest readily visible cultural debris in the project area should be found on ancient surfaces not subject to recent deposition. Such surfaces, of course, may contain cultural debris of lesser age as well.

Among the more important environmental variables affecting plant, animal and human populations is the availability of water. Though located in a rather arid zone where precipitation averages less than 30 cm annually (Franklin and Dyrness 1973:39), parts of the TCOCU, because of their elevation, receive up to 38 cm (Huxel 1966:19, Table 5, in Hattori 1980:4) and possibly more. Greater precipitation combines with lower temperatures and the shelter of north-facing slopes and canyon walls to produce a remarkable concentration of permanent streams and springs, surrounded by extensive lowland areas where surface water is much more difficult to find. Most of these streams are permanent only in the uplands, drying up where they enter the lowland flats. The most notable permanent streams in the project area, proceeding clockwise around the uplands, are Willow, Little Whitehorse, Fifteenmile, Doolittle, Whitehorse, Cottonwood (north), Antelope, Twelvemile, Oregon Canyon, Cottonwood (south), Indian, Cherokee, Mine, Payne, and McDermitt creeks. Permanent springs are plentiful also, occurring largely above 6000 feet.

The climate is continental, with seasonal temperature extremes. July mean maximum temperature is above 31.0°C, while January mean minimum temperature is between -9° and -11°C (Franklin and Dyrness 1973:40-41). Summers tend to be very hot and dry, while winters are cold and snowy. Sunshine in this, the sunniest part of Oregon, is, however, plentiful year-round, so that locations sheltered from the wind but exposed to sunlight can be comfortable in winter.

The annual precipitation pattern is bimodal, peaking in January and May, and dipping to minima in April and July (the driest month) (Boreson et al. 1979).

This climatic regime, combined with geographic isolation from both the Cascade Range and the Rocky Mountains, has resulted in distinctive vegetation that has not been as intensively studied as much of the rest of Oregon. Below 6000 feet the vegetation is composed of familiar variants of the steppe and shrub-steppe communities common to southeastern Oregon and dominated by various species of sagebrush (*Artemisia* spp.), and including also rabbitbrush (*Chrysothamnus* spp.) and various low and high grasses. Above 6000 feet, especially in canyon bottoms and on north- and east-facing slopes, are frequent groves of quaking aspen (*Populus tremuloides*) and mountain mahogany (*Cercocarpus ledifolius*). Aspen is more restricted to moist ground, while mountain mahogany seems to prefer drier and more level ground, such as the ridgetop flats, where extensive groves create a savannah-like appearance. Although aspen on Steens Mountain to the west is found just above a belt of juniper (*Juniperus occidentalis*) (Franklin and Dyrness 1973:246), juniper is almost completely absent from the TCOCU; and, although mountain mahogany frequently is associated with ponderosa pine (*Pinus ponderosa*) elsewhere in Oregon (Franklin and Dyrness 1973:243), pine is almost not found in the TCOCU. Not only are mountain mahogany groves extensive, but the trees themselves tend to be large for the species. Mountain mahogany, because of its extreme density, was a raw material used for the manufacture of such important aboriginal tools as atlatls (Hester et al. 1974), and may have been a preferred material for items such as digging sticks (cf., Boreson et al. 1979:105), for which durability was important.

Game animals appear to be abundant in the project area. Project personnel observed large herds of deer (*Odocoileus* sp.) on the highland flats, where vegetative cover is easily found. Local ranchers informed us that pronghorn (*Antilocapra americana*) are plentiful in the project area, also, wintering in the lowland valleys and moving to the uplands in the spring. Formerly, bighorn sheep (*Ovis canadensis*) roamed throughout southeastern Oregon, in both lowland and upland areas (Bailey 1936), but were decimated early in this century. Similarly, herds of bison (*Bison bison*) were once present, but disappeared at about the time of initial Euro-American contact (Bailey 1936). Our crews observed plentiful game birds, lagomorphs, and other small and medium mammals as well. Also of note as a possible aboriginal food resource is the Whitehorse cutthroat trout (*Salmo clarkii*), a now-rare fish present in the permanent stretches of both Whitehorse and Willow creeks (BLM 1988).

Lithic raw materials also likely influenced aboriginal use of the project area, which contains the source for what is called Whitehorse obsidian, the principal obsidian type used prehistorically at Dirty Shame Rockshelter (Hanes 1988:37). Described in greater detail later in this report, this obsidian is widely represented at sites in the project area, and may have been a stimulus for aboriginal visits to the vicinity. Additionally, the lacustrine sedimentary deposits associated with the McDermitt Caldera are a major source of cryptocrystalline silica (CCS) in many forms, densely deposited in some localities. Petrified wood from ancient forests is a major component, though not the greater part, of this assemblage. Our crews, for example, noticed two petrified tree trunks along the caldera's western edge.

3. CULTURAL BACKGROUND

ABORIGINAL

As summarized by Boreson et al. (1979:99-114), the aboriginal population of southeastern Oregon and the project area at the time of contact was composed of Northern Paiute bands whose places of residence and territories are not well determined. These bands were characterized by low population densities, frequent moves from one resource area to another, and large territories. Bands who may have used the project area include the Atsa'küdökwa tuviwarai ("red butte dwellers") of McDermitt, Nevada, and the Tsösö'ödö tuviwarai, or ("cold dwellers") of Steens Mountain and surrounding deserts (Stewart 1939). The latter group is nearly unknown, but the descendants of the former still reside on the McDermitt Indian Reservation and environs, and once used most of the Quinn River drainage area.

Specific information about the two Northern Paiute bands noted above is very limited, and the locations of their settlements and camps are not known except very generally. The general Northern Paiute lifeway (Boreson et al. 1979:99-114; Steward and Wheeler-Voegelin 1974) may have been similar to the Surprise Valley Paiute described by Kelly (1932). Houses are likely to have been simple and impermanent, not involving an excavated pit. Burials may have been located in talus pits. Though a wide variety of vegetable foods was the basis for the diet, many animals were hunted, including deer, antelope and sheep, sometimes hunted from blinds that may be recognizable archaeologically. Weirs were used for fishing. Stone tools were nearly the only non-perishable items in regular use. Stone boiling was known, but much food preparation did not require it.

The Northern Paiute, however, may not be an ideal analogue for the interpretation of prehistoric sites, since they may have arrived in the northern Great Basin less than 1000 years ago. Glottochronological analysis suggests that the time of divergence between Northern Paiute (or Paviotso) and other Numic languages (Ute-Chemehuevi and Shoshone) is only about 1000 years (Hale 1958). The Northern Paiute may have migrated into Oregon from the south approximately 1000 years ago from somewhere in southeastern California, Arizona, or the central Great Basin (Aikens and Witherspoon 1985; Bettinger and Baumhoff 1982; Goss 1968; Gunnerson 1962; Hopkins 1965; Lamb 1958; Simms 1983; Sutton 1986). On the basis of archaeological data, some feel that the ethnographic distribution of Numic speakers is many thousands of years old (Corliss 1972; Swanson 1966), and even linguists are not in agreement on the degree of difference among the Numic languages. There is, nevertheless, the distinct possibility that some cultural group other than the Northern Paiute inhabited the northern Great Basin prior to 1000 years ago, and that archaeological research will recover evidence of an earlier and somewhat different lifeway.

Table 3.1 lists the archaeological references for the TCOCU area and surrounding regions in Oregon, Idaho and Nevada. The earliest archaeological work in the general vicinity was in the 1930s by Cressman and his colleagues, who established the fact that human occupation was quite ancient, involving thousands of years of prehistory. Systematic archaeological survey of the area, however, did not begin until several decades later, in the late 1960s and early 1970s, when the attention of archaeologists turned to regional rather than site-specific patterns, and land-managing government agencies were directed to inventory their holdings. Through a combination of research projects organized by archaeologists, and inventory and data recovery projects initiated by agencies such as the BLM, site distribution patterns in several parts of the Oregon-Idaho-Nevada border region have become known in varying degrees of detail. These include the Alvord Desert (Pettigrew 1975, 1984), Steens Mountain (see Table 3.1), the Owyhee Uplands of southwest Idaho (largely through work conducted by Plew, and summarized by Ames [1982]), the Black Rock Desert of Nevada (references in Table 3.1 by Clewlow, Cowan, Hanes and McGuckian, Hester, Lohse, and Seck), and the High Rock Country of Nevada (references in Table 3.1 by Layton, Layton and Thomas, Lohse, and McGonagle). The best data on regional chronology come from the stratified deposits of Dirty Shame Rockshelter in the Owyhee Uplands of Oregon (see Table 3.1), and obsidian hydration work in the High Rock Country by Layton (1972, 1985). The clearest picture of settlement pattern changes throughout the Holocene comes from survey work in the Alvord Basin by Pettigrew (1984), combined with the results of the Steens Mountain survey (Beck 1984; Jones 1984; Wilde 1985). Climatic changes are best outlined by Mehringer and Wigand (1988) and Wigand (1987), in their analysis of pollen cores for the Steens Mountain project.

Altogether, it appears that human occupation of the Oregon-Idaho-Nevada border region is as old as in any other part of North America, with the earliest recognized cultural horizon identified with fluted points. The chronology of land use offered by Pettigrew (1984) for the Alvord Basin area, separated by only 11 miles from the present project, may be the most applicable model for the TCOCU. According to Pettigrew's scheme, there have been four adaptive modes over the past 12,000 years, the first of which, the Paleo-Indian (12,000-11,000 B.P.), was short-lived, consisting of fully nomadic foragers specializing in large herd animals. Much more persistent and perhaps more successful was the Western Pluvial Lakes Tradition (11,000-7000 B.P.), composed of collectors concentrating on the then-wet bottomlands and spending little time in upland areas (cf., Bedwell 1969, 1973). The human population may have been substantial, depending on lake and marsh resources such as waterfowl, plant foods, and herbivorous mammals. Mid-Holocene climatic warming and drying forced a near abandonment of the formerly wet basin bottoms, and a shift to the hypothesized Transitional Archaic (7000-5000 B.P.), when population density dropped to very low levels, upland use became essential to subsistence, bands occupied large territories and moved more frequently, and the former emphasis on animal products shifted to plant foods. Adopting innovative hunting and gathering techniques, by the end of the period human groups were more economically efficient, more adaptable to dispersed resources, more numerous, and again concentrated in the lowlands. The final adaptive mode was the Full Archaic (5000 B.P.-contact), the culmination of the changes that took place in the Transitional Archaic. The climate reverted to cooler and wetter conditions, making the new adaptive strategy, broadly based but dependant largely on roots and seeds, even more successful than it had been. Wintertime food storage and fixed lowland winter settlements were adopted. The economic system was a

Table 3.1. Archaeological References Arranged According to Project and Geographic Area.

Southeast Oregon south and east of Malheur National Wildlife Refuge:

Botti 1979a, 1979b, 1979c
Butler 1970
Cannon 1981
Cole 1977
Cole and Pettigrew 1978
Crespin 1984
Cressman et al. 1940
Cressman et al. 1942
Fagan 1974
Flenniken and Stanfill 1979, 1980
Goheen 1982a, 1982b
Goheen and Hosford 1981
Hattori 1980
Hosford 1982a, 1982b
Hosford and Goheen 1982a, 1982b
Hubbard 1967
Marti 1978, 1979, 1981, 1983
Marti and Steggell 1979
McLane 1981
Minor 1979, 1980
Morris 1981
Newman et al. 1975
Oman 1984a, 1984b
Pettigrew 1975, 1977, 1984
Pettigrew and Cole 1977
Plew 1985a, 1985b, 1985c, 1985d
Polk 1977
Pullen 1976
Southard 1969
Todd 1982
Todd-Enneberg 1983a, 1983b, 1983c, 1983d

Steens Mountain:

Aikens et al. 1979, 1980, 1982
Beck 1984
Jones 1984
Wilde 1985

Dirty Shame Rockshelter:

Adovasio et al. 1977
Aikens et al. 1977
Grayson 1977
Hall 1977
Hanes 1977, 1980, 1988
Kittleman 1977
Sanford 1977

Owyhee Uplands, Southwest Idaho:

Ames 1982
Huntley 1982
Metzler 1976, 1977
Olson 1940
Plew 1976a, 1976b, 1978a, 1978b, 1979a, 1979b, 1979c, 1980a, 1980b, 1980c, 1981, 1982, 1985e
Plew and Woods 1982
Shellback 1964
Swanson et al. 1964
Torgeson 1982
Tuohy 1963

Northwest Nevada:

Clewlow 1968, 1981, 1983
Cowan 1972
DeBloois 1976
Elston et al. 1978
Elston and Davis 1979
Hanes and McGuckian 1987
Hester 1977
Layton 1970, 1977, 1979, 1985
Layton and Thomas 1979
Lohse 1980
McGonagle 1979
Moen 1978
Seck 1980

centrally based collection strategy, with seasonal camps used by task groups throughout each group's territory, and the human population markedly increased, reaching a peak between 3000 and 2000 B.P. Owing to the larger population and the wide range of ecozones utilized, this mode is the most heavily represented by the archaeological record, in both the uplands and the lowlands.

It appears that archaeological research in the region surrounding the TCOCU has reached a stage at which understanding of basic prehistoric patterns has begun to crystallize. Views are converging toward the realization that important and detectable shifts in both climate and cultural adaptation took place within the past 11,000 years, but the details of the picture are still clouded by imperfect data on chronology, paleoenvironments, and archaeological site distribution.

Pettigrew's model of land use proposed for the Alvord Basin receives support from studies in adjacent and surrounding areas. The bottoms of other dry basins, particularly Coyote Lake (Butler 1970; Southard 1969) and the Black Rock Desert (e.g., Clewlow 1968, 1983; Cowan 1972; Hanes and McGuckian 1987; Lohse 1980), have revealed heavy concentrations of Western Pluvial Lakes Tradition artifacts and sites, reinforcing the notion that early Holocene adaptation focused on the margins of lowland lakes and marshes. Though only a limited amount of systematic survey has been conducted in the Black Rock Desert area, it would appear (as summarized by Hanes and McGuckian 1987 and Lohse 1980) that mid-Holocene dart points are widely distributed, but not concentrated on the lowland bottom, and that late Holocene arrowpoints are found very commonly at spring sites at varying elevations. Such a pattern is generally similar to that described for the Alvord Basin. Beck (1984) and Jones (1984) see relatively sparse use of the Steens Mountain uplands prior to 4000 B.P., a peak in intensity of upland land use between 4000 and 2500 B.P., fewer but larger sites between 2500 and 1500 B.P., and more but smaller sites after 1500 B.P. This pattern fits nicely with the assessment by Pettigrew (1984) that population density and upland land use increased after 5000 B.P. Wilde (1985) documents intense occupation of the lowland Skull Creek Dunes until the Mazama ash fall just after 7000 B.P., when an occupational hiatus occurred until 3300 B.P. Fagan's (1974) study of upland spring sites in southeastern Oregon shows that, while only four of nine upland sites were used prior to 7000 B.P., eight of nine were occupied after 7000 B.P. Again we have support for the concept that a narrow lowland focus terminated by 7000 B.P. Plew (1982) states that there is no evidence of human use of the Owyhee Uplands in Idaho (which are generally higher in elevation than the Owyhee Uplands in Oregon) prior to 6000 or 7000 B.P. At Dirty Shame Rockshelter in the Owyhee Uplands of Oregon (Hanes 1988), occupation was light prior to 6800 B.P., then became more intense with an increase in plant food collecting, and finally ceased at about 5900 B.P. Re-occupation occurred at about 2700 B.P. with some of the heaviest use experienced. This pattern fits the model quite well, since the prediction would be little or no use during the time of the Western Pluvial Lakes Tradition (11,000-7000 B.P.), then possibly more intense use during the Transitional Archaic (7000-5000 B.P.), then use as a base camp in a centrally-based seasonal round after 5000 B.P. The hiatus from 5900 to 2700 B.P. can be explained as abandonment of a specific site during a period of low population density and re-occupation during a period of increasing population by a centrally based logistical system.

At our present state of understanding, however, the proposed model of changing land use must be considered an hypothesis in need of further confirmation as well as more fine-grained characterization. The model would predict that human use of the TCOCU was light and transitory prior to 7000 B.P., and that most cultural debris found would date after 5000 B.P. Some localities (e.g., Dirty Shame Rockshelter) may have received intense use as early as 7000 B.P., but, owing to low population density, few of these sites should be found. If the wettest period since the mid-Holocene was between 3000 and 2000 B.P., then that period should reflect the greatest amount of cultural debris.

What is not clear from the model is the question of the type of settlement system and seasonal round prior to 5000 B.P., particularly as regards winter settlements. Were winter settlements composed of small family groups or were they larger concentrations of people? Were the same winter sites used from year to year? Were winter sites during the Transitional Archaic located at upland springs or streams, where water was reliable? Were wintering areas during that time widely scattered, such as on the Humboldt River, Snake River, and other large water bodies, or were they distributed at narrower intervals including places such as the permanent creeks in the TCOCU project area? During the warmer times of the year, was a logistical system used or was the pattern more similar to foraging? Were upland base camps established, or was most food collection accomplished during day trips? Though the model establishes general expectations regarding economic orientation, it does not go far toward specific characterization of the settlement system. Such improvements can be expected when a better database is available.

EURO-AMERICAN

The first Euro-Americans in southeastern Oregon were probably trappers. Competition for fur trapping territories (and, ultimately, political domination) led British and American fur trading companies to explore new regions in search of profitable beaver-inhabited streams. Among the expeditions which journeyed into southeastern Oregon were Wilson Price Hunt's party of 1811, Robert Stuart's party of 1812, Donald McKenzie's expeditions of 1818 and 1819, Peter Skene Ogden's expeditions between 1824 and 1829, and John Work's expeditions between 1830 and 1832 (Boreson et al. 1979:115). Based on interpretations of journal entries, it appears that the later two entered, or came close to, the TCOCU project area. On June 14, 1829, Ogden's Fifth Snake River Expedition apparently crossed McDermitt Creek about 15 miles west of the town of McDermitt, and proceeded northwest to the Trout Creek drainage (and thus crossed through the southern portion of the project area). John Work's First Snake Expedition passed within or near the TCOCU project area in late June, 1831, when they crossed McDermitt Creek on a northward journey (Boreson et al. 1979:125; Hattori 1980:9).

In the Pacific Northwest as a region, the period of exploration was followed by a period of immigration, beginning with missionaries, and subsequently with settlers. Increasing Euro-American population pressure resulted in the inevitable conflicts with Native Americans; the result was a period of military activity, during which the aboriginal occupants of southeastern Oregon were either forced onto reservations, or exterminated (often with the aid of Indians from the Warm Springs Reservation, who took advantage of the opportunity to fight their traditional enemies [Boreson et al. 1979:137-139]). Fort McDermitt was established in 1865 during this period of hostilities, and the McDermitt Indian Reservation was subsequently started.

Initially, the military in southeastern Oregon was used to escort immigrant parties on the Oregon Trail, to explore uncharted territory, and to locate supply and communication lines (Boreson et al. 1979:134). As part of this effort, Camp Alvord was established in June, 1864, at the eastern base of Steens Mountain. The camp was moved to Wildhorse Creek in September, 1865, and subsequently moved 25 miles southeast to Whitehorse Creek (approximately one mile northeast of the current location of the Whitehorse Ranch) in June, 1866, and at that time renamed Camp C. F. Smith (McArthur 1982:105,107). One purpose of the camp was to protect the Oregon Central Military Road, which passed both old Camp Alvord and Camp C. F. Smith; the camp and the road would thus be in or near the northern boundary of the TCOCU project area. The camp was abandoned on November 9, 1869 (McArthur 1982:107).

General Crook temporarily used Camp C. F. Smith as a base during his campaign of extermination of non-reservation Indians during 1866-1867. Several battles were waged in the surrounding vicinity, particularly in the Pueblo Mountains and near Alvord Creek (Boreson et al. 1979:147-148); hostilities may have also taken place within the TCOCU project area, as Angel (1958:169, in Hattori 1980:12) notes that Disaster Peak, in the southwest corner of the project area, was named after an Indian ambush killed four prospectors in May of 1864.

An organized road system in southeastern Oregon began with military supply routes, which, with expanding population growth, became increasingly used for civilian supply and transportation routes. As mentioned above, the Oregon Central Military Road passes through or near the northern portion of the TCOCU project area; this road was started in 1864, and completed in 1870. The Idaho Stage Company Line, a tri-weekly stage line, was established in 1865, and also passes near, or in, the northern portion of the project area (Boreson et al. 1979:154-158).

Economic development in southeastern Oregon, particularly in the vicinity of the TCOCU project area, has, for the most part, consisted of mining and ranching. Ranching started in the 1860s to provide beef, mutton, wool, and horses to the mining communities and to the military. In 1868, John Devine brought 2500 head of cattle to the Whitehorse Creek area, and started the Whitehorse Ranch. The project area vicinity was open range until the late 1870s, at which time ranchers began to fence private land. Overgrazing on public domain became a serious problem; with the passage of the Taylor Grazing Act of 1934, the Bureau of Land Management began to regulate grazing on public lands (Boreson et al. 1979:161-162).

Although mining in other parts of southeastern Oregon (and in southwestern Idaho) started as early as the 1860s, mining in the project area vicinity did not start until July of 1917, at which time William Bretz founded the Bretz Quicksilver Mine in the McDermitt Creek Drainage (although Bretz filed on the claim in 1917, it was not actively mined until 1931). Bretz also established the Opalite Mine (also in the McDermitt Creek Drainage) in 1924 (Boreson et al. 1979:184). Mining continues to be an important activity in the project area vicinity, especially in the south, near McDermitt Creek, with numerous mining claims located within the project boundaries.

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4. SAMPLING DESIGN AND PROCEDURES

BASIC CONCEPTS

The major object of the field survey was the collection of data relevant to management concerns and the interpretation of human land-use patterns. Additionally, some emphasis was placed on the addition of significant data to the existing inventory for the locality. For example, most stratified rockshelters on record had been damaged by unauthorized excavations, so it was important to learn if more such key sites still existed. Thus, the research was designed both to investigate general patterns of cultural resource distribution on the basis of the selected survey units, and to record a substantial number of cultural resource sites.

The project area as defined contains approximately 287,000 acres of BLM land, of which the 5,000 acre survey comprises only 1.7%. Given this relatively small percentage, survey tracts had to be located intelligently in order to assure the sample's representativeness of the project area. The need to maximize the discovery of cultural resource sites somewhat complicated the design of a sampling strategy, since it became necessary to create a predictive model and to over-represent what are considered high probability areas. Nevertheless, it was possible to stratify the project area on the basis of predictive modeling criteria, and emphasize high probability areas, provided that low probability areas were also sampled sufficiently to test the bases for their probability classification. In doing this, we were aware of the risk that the "low probability" sample would be insufficient, an outcome that cannot be known without additional confirming survey (Berry 1984; Darsie and Keyser [ed.] 1985; Tainter [ed.] 1984).

The authors gave much consideration to the kinds of sampling tracts to use. One idea, following the Steens Mountain project (Aikens et al. 1982), was to use fourth-order drainage basins as survey units. This option has appeal, since such parcels are relatively easy to locate and demarcate on the ground, and have some intuitive value as land-use units. However, we rejected that idea for several reasons. Small drainage units tend to focus attention away from ridges, which may be prime locations for sites. They also are difficult to measure and control for surface area. Importantly, they may not be distributed in a manner representative of the project area: they tend to be smaller and more highly concentrated in the high uplands, and larger and fewer in the lower areas. Moreover, the definition of fourth-order drainages in a topographically complex area such as the TCOCU can be difficult in practice. The alternative adopted was the square quadrat, in this case defined as the quarter-section (approximately 160 acres). Though square units in rugged terrain present some practical difficulties of access and ground location, they have a generally fixed surface area and can be well controlled for sampling purposes. They are distributed evenly over the landscape, and do not bias our attention toward or against particular topographic or other geographic features. They are classifiable by environmental criteria, and well demarcated on existing maps.

Testing preconceptions about land-use patterns, and assuring that what are considered important subsets of the project area are covered adequately, required that the project area be stratified, and that it be appraised according to important environmental parameters. These parameters, including elevation, slope, major drainage area, permanent streams, main stem intermittent streams, springs, ridge lines, and rimrock, emerged from consideration of variables that were likely to have influenced the use of locales, and which were also practical to quantify from existing maps. Stratification for purposes of assuring even coverage made use of two variables, elevation, and major drainage area. Although vegetation types are reflective of important biotic zones, the existing vegetation mosaic may not represent past periods and thus was not included among the environmental variables.

GEOGRAPHIC DATABASE

To make use of environmental variables in selection of sample quadrats, the authors built a computerized database (using dBASE III PLUS) of potential quadrats in the project area, of which there are 1889. Each quarter-section parcel in the project area was encoded with information drawn from available maps according to the environmental variables listed above as well as other data fields such as township, range, section, quarter-section, and surface area of BLM land within the quadrat (see field definitions, Table 4.1). The values for the variables are considered to be attributes of the quadrats (independent variables), to be used in selecting the sample of quadrats to survey and in analyzing the environmental associations of the discovered archaeological sites. Cultural evidence found inside the quadrats is considered a dependant variable, to some extent a function of the environmental variables.

Once the quadrats were encoded on the database, the authors incorporated the environmental variables into a mathematical formula designed to predict the intensity of prehistoric land use within each quadrat. This formula is as follows (see Table 4.1 for definitions):

$$I = (160/B)\,[a(LPS) + b(LIS) + c(SP) + d(LRD) + e(LRM)]\,[f(L) + g(M) + h(H)] + 0.1,$$

where the parameters a, b, c, etc., were assigned values as follows:

$a = 1$
$b = 0.5$
$c = 1$
$d = 0.7$
$e = 0.5$
$f = 1$
$g = 0.3$
$h = 0.1$.

Table 4.1. Definitions of Fields for Geographic Database.

FIELD	DEFINITION
Township	Township (Willamette Meridian)
Range	Range (Willamette Meridian)
Section	Section number within Township
Quarter	Quarter-section within Section
BLM_Area (B)	Acres of BLM land within quarter-section
Elevation	4 - <5000'; 5 - 5000-5999'; 6 - 6000-6999'; 7 - ≥7000'
Drainage	WI - Willow Creek; WH - Whitehorse Creek; TW - Twelvemile Creek; OC - Oregon Canyon Creek; IN - Indian Creek; MD - McDermitt Creek
LPS (Length of Permanent Stream)	Km of permanent streams, as indicated by USGS 7.5 min. quad map
LIS (Length of Main Stem Intermittent Stream)	Km of such streams, as indicated by USGS 7.5 min. quad map. Main stem intermittent stream defined as intermittent stream with at least one tributary.
LRD (Length of Ridge Line)	Km of ridge line, as indicated by USGS 7.5 min. quad map. Considers only those ridges at least 3.2 km (2 miles) in total length.
LRM (Length of Rimrock)	Km of rimrock, as indicated by BLM 1" - 1 mile map (1969).
Springs (SP)	Number of spring symbols on USGS 7.5 min. quad map within Quarter-section
Low_Slope (L)	0-29% slope, where 100% - 45°. Code: 0 - <26%, 1 - 26-50%, 2 - 51-75%, 3 - 76-100% of BLM Land within Quarter-section, as indicated on USGS 7.5 min quad map.
Med_Slope (M)	30-59% slope. Same code as above.
High_Slope (H)	>59% slope. Same code as above.
Intensity (I)	Predicted intensity of prehistoric land use.

The first major factor in the formula, 160/B, norms the value of I to compensate for those quadrats where BLM land is less than the entire quadrat. In such units the potential values of the environmental variables are the inverse of the area's proportion of 160 acres (the assumed area of each standard quadrat). The second major factor contains the environmental variables (LPS, LIS, SP, LRD, and LRM) that are thought to have attracted prehistoric land use. The greater these values, the greater land-use intensity is assumed to have been. The third major factor was intended to adjust the predicted land-use intensity according to the slope, which was considered to have a strong influence. Steep slope was believed to inhibit the human use of what on other bases (such as presence of water) might be an attractive locale. Finally, the value 0.1 was added to the formula to assure that no predictions of absolutely no human land use can occur. Despite the most discouraging of environmental factors in a particular quadrat, some human use is possible. The minimum value of I, therefore, was 0.1.

The parametric values (a, b, etc.) were assigned purely judgmentally, on the basis of assumptions regarding the attractiveness (or lack thereof) of the variables. Parameter b was given half the value of parameter a because it was assumed that streams with permanent water today always have been more dependable water sources. Parameter c was the same as a because springs were considered to be as attractive as permanent streams. Rather than the actual number of springs, we used the square root of that number so as to avoid overestimating land-use intensity in cases where many springs existed in a quadrat. Several springs close together may not have been much more attractive than one or two within such a small area as a quarter-section. Values for parameters d and e were assigned in proportion to the judged relative attractiveness of ridge lines and rimrock compared to permanent streams and springs. Rimrock, of course, is a key factor in the location of rockshelters, rock art sites, and possibly other site types. Since it was assumed that most sites would be in areas with low slope, parameter f was given a value of 1, while g and h were given much smaller values in anticipation of the relative rarity of sites in steeper areas.

Predicted land-use intensity (I) is not considered to be a direct predictor of or a surrogate for the presence or amount of archaeological sites or cultural debris. Intensity is conceived to mean the frequency and duration of the human presence on the landscape within a given period of time. Such frequency and duration can result from a number of activities, including travel through an area, extractive activity such as hunting, collecting or quarrying, ceremonial activity such as vision quests or the creation of rock art, overnight or seasonal camping, and habitation. Each of these activities may leave a different imprint, or none at all. Generally, however, it is expected that the greater the land-use intensity, the greater the probability and amount of durable cultural evidence, whether in the form of land alteration, cultural features, or cultural debris. Furthermore, although intensity is meaningful in terms of a given unit of time, cultural evidence on a particular piece of land is generally additive (i.e., accumulates with the passage of time), so that land-use intensity may be masked by the length of time the area was used. High intensity for a short time may be indistinguishable from low intensity over a much longer time in terms of the cultural imprint on the landscape. These complications must be kept in mind when considering the connection between predicted (or actual, for that matter) land-use intensity and the total amount of cultural evidence present within a quadrat.

If our concern is purely the prediction of the location of cultural resource sites for the purposes of their management, then the question of whether intensity fluctuated over time may be of limited importance, since the total amount of cultural resources is what matters. The intensity values can be quite useful in this context, regardless of temporal concerns, to the extent that they predict the frequency of sites and cultural debris. However, once we direct our attention to questions about particular time periods, or about changes over time in land-use patterns, then land-use intensity within specific time frames becomes an important object of research, and we must find and make use of chronological indicators. The predicted land-use intensity, by itself, is not associable with specific periods, unless we posit that parameters determining intensity changed over time in certain specific ways. For this project, no such temporal variation in parameters was attempted, and it was assumed that the attractiveness of the environmental variables remained constant. Such an assumption may not be fully realistic, but it is prudent to make for purposes of this project at our current level of understanding. Once sufficient data are collected and analyzed, more sophisticated models may become possible. Though culture change is not part of the model, this research addresses changes in land-use intensity through the analysis of temporally variable projectile point morphology, as discussed later in the report.

SAMPLING STRATA AND QUADRAT SELECTION

Selection of quadrats (in this project, quarter-section units) for field survey was a process undertaken with great care. The authors understood from the beginning that 5000 out of 287,000 acres is such a small sample (1.7%) that assuring its representativeness was no small task. An important part of the process of maximizing representativeness was the division of the project area and the sample into sampling strata. Such a division guaranteed even coverage of the population through assignment of a fixed portion of the sample to each of the strata.

Prior to this project, information about environmental patterning of the cultural evidence, and about the distribution of what might be assumed to be important resources (such as large mammals, vegetable foods, and lithic sources), was available only in very general terms. Furthermore, even had we known these data to a large extent, we could not have concluded that the biotic patterns had remained constant throughout the Holocene. Thus, it made more sense to base the sampling stratification on fixed geographic parameters, two of which, elevation and drainage basin, were chosen. It was assumed that the distributional patterns of most resources of cultural importance could be described in terms of these two factors, which were easily identified on existing maps.

Project area elevations range from about 4300 to just over 8000 feet, so the simplest divisions for this parameter were the thousands of feet: below 5000, 5000-5999, 6000-6999, and 7000 feet and above. Drainage basins were not quite so straightforward, but were chosen to divide the project area into areas of comparable (though not equal) magnitude, in a somewhat radial pattern. Stream drainages chosen initially were as follows: Willow Creek, Whitehorse Creek, Twelvemile Creek (including the drainage of Antelope Creek), Oregon Canyon Creek, Indian Creek (including Cottonwood Creek, and other McDermitt Creek drainages west of Oregon Canyon Creek), and McDermitt Creek (west of the Indian Creek drainage). The use of four elevational intervals and six drainage areas would require the project area to be divided into 24 sampling strata. In order to select more high-probability than low-probability (conceived in terms of the likelihood of finding prehistoric cultural evidence) area to improve the recovery of cultural data, each stratum would have to be further divided into high- and low-probability units, effectively creating 48 sampling strata to divide into 5000 acres of ground coverage. Our basic quadrat size of 1/4 section (of which there are only 31.25 in 5000 acres) rendered such small sampling units impractical, so we decided to restructure the stream drainages into three larger areas, termed north (Willow and Whitehorse creeks), east (Twelvemile and Oregon Canyon creeks), and south (Indian and McDermitt creeks). In the end, then, there remained 12 areal sampling units, each further divided into high- and low-probability units, for a total of 24 effective sampling strata.

High and low probability were defined simply by means of the predicted prehistoric land-use intensity (I), which ranged from a value of 0.100 to 18.340. Low probability units were those with values of 0.100 to the median of 1.135, and high probability units were those above 1.135. Thus, half of the project area was in each probability group.

To accomplish selection of quadrats for field inspection, the population of 1889 potential quadrats, present in one dBASE III PLUS computer file, was divided into 12 files, one for each geographic sampling stratum. These sampling strata are listed in Table 4.2 according to the area of BLM land, and the percentage of the total project area, within each.

The sampling design required that each geographic sampling stratum be covered according to its proportion of the whole project area. As Table 4.3 shows, the actual acreage selected varied slightly from the ideal sample sizes. These differences resulted from the practical need to survey easily definable parcels. The actual acreage in each case is a multiple of 40, as it was decided that 40-acre pieces were the smallest units that could be readily manipulated and surveyed.

Having decided the sample sizes for each geographic sampling stratum, we proceeded to select the quadrats to be surveyed. In order to maximize the recovery of significant cultural data, it was decided in principle to choose two high-probability units for each low-probability unit. In practice, it was not possible to adhere strictly to this formula, since the actual acreage selected for each stratum was usually not an even multiple of 160, and was most often less than 540. The result was selection of a slightly higher percentage of high-probability (3,520 acres, or 70.4% instead of 66.7%) as

Table 4.2. Acres of BLM Land within Sampling Strata (all percentages are of total BLM land within project area).

Drainage	<5000	5000-5999	6000-6999	>6999	Total
North	25,085	37,315	46,970	13,740	123,110
%	8.72	12.98	16.34	4.78	42.82
East	12,040	39,400	25,040	7,840	84,320
%	4.19	13.70	8.71	2.73	29.33
South	1,200	47,175	24,640	7,085	80,100
%	0.42	16.41	8.57	2.46	27.86
Total	38,325	123,890	96,650	28,665	287,530
%	13.33	43.09	33.61	9.97	100.00

Table 4.3. Ideal Sample Sizes and Actual Acreage Selected within Geographic Sampling Strata (all percentages are of the 5000 acre total sample).

Drainage	<5000	5000-5999	6000-6999	>6999	Total
North	436	649	817	239	2,141
%*	8.72	12.98	16.34	4.78	42.82
(Actual)	440	640	800	240	2,120
%	8.80	12.80	16.00	4.80	42.40
East	210	685	435	136	1,466
%	4.20	13.70	8.70	2.72	29.32
(Actual)	200	680	440	120	1,440
%	4.00	13.60	8.80	2.40	28.80
South	21	820	429	123	1,393
%	0.42	16.40	8.58	2.46	27.86
(Actual)	40	840	440	120	1,440
%	0.80	16.80	8.80	2.40	28.80
Total	667	2,154	1,681	498	5,000
%	13.34	43.08	33.62	9.96	100.00
(Actual)	680	2,160	1,680	480	5,000
%	13.60	43.20	33.60	9.60	100.00

Table 4.4. Quadrats Chosen for Field Inspection (abbreviations on p. 19).

Sampling Stratum	Prob.	Quadrat	Area	LPS	LIS	LRD	LRM	SP	L	M	H	I
NO4	Low	38-38-15-SW	120	0.0	0.2	0.0	0.0	0	3	0	0	0.400
	High	38-38-35-NE	160	0.0	1.0	0.0	0.0	0	3	0	0	1.600
		38-38-27-SE	160	1.2	0.8	0.0	0.0	0	3	0	0	4.900
NO5	Low	39-39-9-SW	160	0.0	0.0	0.0	0.0	0	3	0	0	0.100
	High	39-39-5-SW	160	0.0	0.9	0.0	0.0	0	3	0	0	1.450
		39-39-5-NW	160	0.0	0.8	0.4	0.0	0	3	0	0	2.140
		39-38-24-NE	160	0.0	0.3	0.9	0.7	0	2	1	0	2.699
NO6	Low	39-40-5-SE	160	0.3	0.0	0.0	1.1	0	0	1	2	0.525
		39-39-22-NE	160	0.0	0.7	0.0	0.0	0	1	2	0	0.660
	High	39-39-13-SW	160	0.0	0.0	0.8	0.0	0	2	1	0	1.388
		38-39-23-SE	160	0.0	0.5	0.3	1.7	0	1	2	0	2.196
		40-38-1-NE	160	0.0	0.4	0.8	1.1	0	1	2	0	2.196
NO7	Low	40-38-21-NE	80	0.0	0.0	0.0	0.0	0	2	1	0	0.100
	High	39-40-27-NE	160	0.9	0.0	0.0	0.0	2	1	2	0	3.803
EA4	Low	39-41-36-SE	40	0.2	0.0	0.0	0.0	0	3	0	0	0.700
	High	39-41-11-SW	160	0.0	0.8	0.0	0.0	0	3	0	0	1.300
EA5	Low	38-40-14-SE	40	0.0	0.0	0.0	0.0	0	3	0	0	0.100
		38-40-1-NW	160	0.0	0.3	0.0	0.0	0	3	0	0	0.550
	High	39-41-21-NE	160	0.0	0.0	0.8	0.0	0	2	1	0	1.388
		37-37-13-SW	160	0.6	0.0	0.8	1.5	0	1	1	1	2.774
		37-37-14-SE	160	0.8	0.0	0.9	1.0	0	1	1	1	2.802
EA6	Low	38-40-11-NW	120	0.0	0.0	0.8	0.0	0	1	0	2	0.772
	High	38-40-19-NW	160	0.0	0.0	0.9	0.2	0	3	0	0	2.290
		38-40-20-SW	160	0.0	0.0	1.0	0.6	0	3	0	0	3.100
EA7	High	40-40-12-NE	120	0.0	0.0	0.9	0.7	0	2	1	0	2.354
SO4	High	41-41-20-NW	40	1.0	0.0	0.0	0.0	0	1	1	1	1.967
SO5	Low	41-40-11-SW	160	0.0	0.0	0.0	0.0	0	3	0	0	0.100
		41-41-1-SW	160	0.0	0.6	0.0	0.0	0	2	1	0	0.790
	High	40-40-21-NW	160	0.0	0.8	0.6	0.0	0	1	1	1	1.248
		41-39-12-SE	160	0.0	0.0	0.8	0.0	0	3	0	0	1.780
		41-39-5-SE	40	0.0	0.0	0.0	0.0	1	3	0	0	3.100
		40-40-25-SE	160	0.0	0.9	0.8	0.0	0	3	0	0	3.130
SO6	Low	40-41-19-SE	120	0.0	0.0	0.0	0.7	0	1	2	0	0.660
	High	40-39-14-SE	160	0.0	0.0	0.0	0.9	1	1	2	0	2.420
		41-39-18-SW	160	0.0	0.0	0.0	0.0	1	3	0	0	3.100
SO7	High	40-41-7-NE	120	0.0	0.0	0.9	0.9	2	1	2	0	4.091

opposed to low-probability (1,480 acres, or 29.6% instead of 33.3%) area than initially decided.

Within each stratum, the selection of particular quadrats was left to chance, through use of a random process. Selected quadrats were picked by number (record numbers as listed within the dBASE III PLUS file for each stratum) using the random number generator available on the TI-95 programmable calculator and seed numbers drawn from a random number table. Twelve lists of random numbers were thereby generated, one for each of the geographic sampling strata. Quadrats within each stratum were drawn in order as they fell on these lists, until the appropriate number (and acreage) of quadrats had been chosen for each probability group. In some cases, additional numbers had to be drawn when it was found that the chosen quadrats had already been surveyed by others. In those cases where the total acreage in the chosen quadrats was greater than the targeted amount, quadrats were chosen randomly by coin flips for reduction in acreage to be surveyed. For each quadrat so chosen, coin flips again were employed to select the quadrants (quarter of quarter-sections, or 40-acre parcels) to be either surveyed or omitted, as the situation demanded. The list of chosen quadrats is given above as Table 4.4.

In the same way, a list of alternate quadrats was created, for use in cases where surveyors in the field found that an originally chosen quadrat was not accessible, or for some other reason needed to be replaced. Fortunately, reference to this list in the field was never necessary.

FIELD METHODS

Prior to the field survey, several tasks were undertaken to ensure successful completion of the project. First among these was a review of documents and reports pertaining to the project area. Subsequently, a meeting was held with BLM archaeologists to discuss project management, site definitions, and site and isolate recordation strategies. Maps delineating previously surveyed areas and sites recorded within the project area were provided by the BLM. A range of numbers for site designation was also provided at this time. The authors then spent a day driving through the project area, as an aid to developing field strategies. Prefield research was completed with compilation of the detailed geographic database (discussed above) used to draw the survey units.

Fieldwork was completed in three separate sessions: October 13-17, October 25 - November 2, and November 9-12, 1988. The Field Director and three Field Technicians carried out the first session, the Principal Investigator, Field Director, and four Field Technicians conducted the second session, and the Field Director, Crew Chief, and four Field Technicians completed the last session. With the exception of the first session (when a single crew of four was employed), the survey was done with two crews, each comprised of two Field Technicians and a crew leader (either the Crew Chief, Field Director, or Principal Investigator). Generally, the two crews surveyed independently, in different quadrats, although in many instances the two crews worked together on the same quadrat. The Field Technicians were rotated between the crews on a daily basis as a means of reducing inconsistencies between crews.

Each session started with an orientation presented by the Field Director (and, when present, the Principal Investigator). Background information and the goals of the project were discussed, as were the survey and recordation techniques to be employed. Crews were instructed not only to look for lithic artifacts, but also to examine rock outcrops and rimrock for rockshelters and rock art, and to be aware of the possible presence of rock features, historic structures, historic debris, mining tailings, and dendroglyphs. The orientation sessions concluded with an exercise in pacing. Standard equipment used by all surveyors included a compass, tally counter, flagging, and clipboard and pencil. On a daily basis, each surveyor was provided with a map of the survey quadrat, consisting of an enlarged USGS map (at a scale of 1 cm to 60 m -- see Appendix B).

As the ultimate goal of the project was to learn as much as possible about the total land-use patterns of the TCOCU project area, it was deemed necessary to record the distribution of all cultural debris within the survey quadrats, and not just focus on the high density concentrations ("sites"). In this manner, a broader, and more complete, picture of the total articulation of man with the environment can be compiled (Dunnell and Dancey 1983), and the many problems with site definitions (Tainter 1983) can be alleviated. Towards this end, the location of all observed cultural debris was plotted on a quadrat map to the nearest 30 m (see the discussion below). However, because the concept of a "site" does serve as an aid for conceptualizing and classifying concentrations of cultural debris (not to mention serving as a tool for cultural resource management), we developed an arbitrary operational site definition (based largely on previous experience by the authors, consultation with BLM archaeologists, and on reviews of sites previously reported in southeastern Oregon): 10 or more cultural items in an area smaller than or equal to 100 m^2. In addition, site type influenced the site definition. Rockshelters, even if containing less than 10 cultural items, were considered to be sites; rock features were considered sites regardless of presence of other cultural debris; and, although none were observed during the survey, a location of rock art was considered to be a site.

In order to best accomplish our goal of complete recordation of the distribution of cultural debris across the landscape within our survey quadrats, our basic survey strategy consisted of straight, parallel, pedestrian transects spaced at 30 m intervals. These transects were oriented in cardinal directions (east-west or north-south). Transect spacing was established by pacing. To maintain transect spacing, flagging was tied at the terminus of the next transect to be walked, thus marking the end point for the adjacent, return transect; flagging was also periodically tied on the outside (the third of three) transect traversed, to serve as a guide for the adjacent, return transect. However, due to steep slopes and frequent rimrock, it was not always possible to traverse in straight transects. In those cases where it was physically too arduous to climb straight up and down steep slopes, or to continue climbing over rimrock, transects were adjusted to be parallel, or close to parallel, to the topographic contours. Care was taken to maintain 30 m transect intervals in these situations. In those rare instances where it was deemed too dangerous to traverse an area (in every case, due to extremely steep talus slopes), the slope was not walked, but was observed from vantage points to ensure that rockshelters and other features were not missed.

In addition to spacing transects at 30 m intervals, each transect was traversed in 30 m increments (determined by pacing, with landmarks on the ground and corresponding landmarks on the quadrat map used to correct pacing errors). The quantity of cultural debris, raw material types, tool types, and historic debris observed in each 30 m increment was recorded on the individual quadrat maps. To aid in data recording, the quadrat maps supplied to each surveyor had a grid of 30 m squares superimposed over the enlarged map. As each surveyor finished a 30 m increment, the data for that increment were recorded in the appropriate location on the quadrat map (see Appendix B). Due to the difficulty of simultaneously counting both paces and cultural materials, tally counters were used to maintain a count of cultural materials per 30 m increment. In those areas with concentrations of cultural debris too dense to use tally counters, estimates were made of quantities of cultural debris (the density at which it was too great to use the tally counter varied with individual surveyor, but was generally over 20 items).

Data recordation was greatly aided by this means of surveying. As our operational site definition was 10 or more items per 100 m^2, it was determined that a quantity of 10 or more items per 30 m increment on a given transect constituted a site (this assumed that each surveyor visualized a path between three and four meters wide while walking transects -- in rare cases where decreased surface visibility reduced this path of visualization, a correspondingly reduced number of items per 30 m increment constituted a site). It should be noted, however, that an isolated instance of 10 items in a 30 m increment was not recorded as a site; only those areas with more than 10 items per 30 m increment, or contiguous 30 m increments with 10 or more items, were recorded as sites. Site boundaries were drawn to exclude those areas with a density less than 10 per 100 m^2, or transect increments with less than 10 per 30 m increment. In a some cases, such as sites situated on sharp ridges, knolls, or adjacent to rimrock, the site boundaries were either completely or partially topographically defined.

Our survey strategy, therefore, consisted of each crew member of a crew concurrently walking transects, recording quantities (and the attributes mentioned above) of cultural debris per 30 m increment. If more than ten items were observed within a given increment, and it appeared to be an isolated instance, the location was recorded as a site (see discussion below). If multiple contiguous increments or transects contained more than 10 items, the surveyors continued to traverse until the density dropped below 10 items per 30 m increment. In rare cases, an isolated incident of less than 10 items per 30 m increment would be completely surrounded by increments with 10 or more items; in these cases, the area of lower density was included within the site.

Site recordation consisted of determining site boundaries on the small sites (those less than 900 m^2 -- the boundaries on the larger sites was determined by the quantities of cultural debris per traverse increment), and plotting the site location on the quadrat map; site recordation also included noting the raw material types, types of tools present, presence of any features, and size ranges of the lithic debitage. The environmental setting was also recorded. The site was photographed on black and white film, and often with color slides, and, in those instances where features were identified, sketches made of the features, site, or both. The sites were documented on standard forms provided by the BLM, and assigned a number from the range of numbers issued by the BLM. Sites were recorded in their entirety (even if the site extended outside the survey quadrat), with the exception of very large sites, where it was considered impractical to find site boundaries outside the quadrat boundary. The boundaries of sites were not flagged.

Only temporally diagnostic tools (projectile points and crescents) were collected (both within sites and as isolates). Once found, such tools were placed in coin envelopes, assigned a unique number, and their location plotted on the quadrat map.

No subsurface testing was conducted in conjunction with this project.

Data compilation and analysis began upon the completion of the fieldwork. The first step in this phase of the project was cataloguing, measuring, and classifying the collected tools. Another important part of this phase was compiling the data from each individual surveyor's quadrat map onto a master quadrat map, thus producing a single map for each quadrat which shows the distribution of cultural debris across the quadrat (see Appendix B). These maps also show the location of sites, although the quantities of cultural debris within the sites was not included, due to a lack of space on the maps (instead, the quantities of cultural debris within the maps is graphically represented by isopleths). It was also impossible, due to a lack of space on the master quadrat map, to include the data on raw material types, tool types, and to distinguish prehistoric from historic materials. The data from all the master quadrat maps, including the information which could not be shown on the maps (such as material types), were then compiled for analysis (see tables 5.8, 5.9, and 5.11). The pertinent data from the site records were also compiled for analysis. The locations of all the survey quadrats and sites located were indicated on USGS topographic maps, as separate deliverables to the BLM. The site data were encoded on a computer file using BLM's dBASE III PLUS program ARCSITE, and also submitted as a separate deliverable.

5. RESULTS

The purpose of this chapter is to discuss the results of IRI's cultural resource survey of the TCOCU project area. In order to provide a setting in which to interpret the results, the chapter begins with a quantification of the environmental variables as analyzed through the geographic database, then characterizes the physiography of the surveyed quadrats, and describes the archaeological sites documented during the survey. The heart of this report is then contained in the following sections, beginning with the quantitative and qualitative presentation of the data derived from the environment, the sites, and from the distribution of cultural materials across the quadrats. These data then are associated with environmental variables, allowing an examination of human land-use patterns within the TCOCU. The results of the analysis are evaluated in the final section of this chapter.

QUANTIFICATION OF ENVIRONMENTAL VARIABLES

The geographic database created for this project contains a wealth of data that we have tapped only modestly here. Numerical analysis of key environmental variables in the database was carried only so far as to measure values (normed by unit area) of the variables for each of the sampling strata (defined by elevational range and drainage area). This simple analysis serves to show the systematic variation of the environment across the project area, especially in regard to elevation. The discussion below is based on the numerical results summarized by Table 5.1.

The length of permanent stream (LPS) does not vary greatly by elevation or drainage, although the lowest elevational interval of the south drainage certainly has by far the greatest proportion. There is a slight tendency for LPS to increase with higher elevation up to 7000 feet. The total length of intermittent streams (LIS) is somewhat greater than the length of permanent streams, with the proportion of intermittent streams decreasing markedly with increasing elevation in all drainages; the east drainage has a significantly higher proportion of intermittent streams than the remainder of the project area. The length of rimrock (LRM) is the lowest of the environmental variables measured by distance, but overall it increases with increasing elevation, although this pattern does not hold for the north drainage, where the 5000-5999 foot elevation interval has the highest proportion of rimrock, and then decreases with increasing elevation. This exception occurs because of the northwestward slope of the upland fault block and the lengthy canyons in the north drainage area. The east drainage has proportionately the greatest length of rimrock, nearly three times that of the south drainage. The length of ridge (LRD), numerically the greatest of the environmental variables measured, increases dramatically with increasing elevation, a pattern existing in all drainages. The number of springs also increases with increasing elevation, except in the south, where the highest and lowest elevational intervals have proportionate frequencies of springs several times higher than the intermediate intervals. The lowland springs there may reflect

Table 5.1. Frequency of Environmental Variables, Derived from Geographic Database, by Drainage and Elevation, for the TCOCU Project Area. Values are expressed per 1000 acres.

ENVIRONMENTAL VARIABLE	ELEVATION RANGE	DRAINAGE			
		NORTH	EAST	SOUTH	TOTAL
LPS	< 5000	0.74	0.66	3.67	0.81
	5000-5999	1.48	0.77	1.04	1.09
	6000-6999	1.27	1.35	1.12	1.26
	≥ 7000	0.48	1.00	1.40	1.02
	TOTAL	1.14	0.95	1.13	1.08
LIS	< 5000	1.86	3.10	1.17	2.23
	5000-5999	1.27	2.19	1.78	1.75
	6000-6999	0.56	0.80	0.64	0.64
	≥ 7000	0.07	0.29	0.37	0.25
	TOTAL	0.98	1.73	1.17	1.29
LRM	< 5000	0.88	0.17	0.25	0.64
	5000-5999	1.39	1.41	0.12	0.91
	6000-6999	0.79	1.78	0.89	1.07
	≥ 7000	0.55	1.90	1.48	1.39
	TOTAL	0.97	1.39	0.48	0.95
LRD	< 5000	0.28	0.42	0.00	0.32
	5000-5999	1.66	1.16	0.96	1.23
	6000-6999	2.54	1.93	1.86	2.21
	≥ 7000	2.96	2.74	2.51	3.38
	TOTAL	1.86	1.44	1.36	1.59
SPRINGS	< 5000	0.24	0.00	7.50	0.39
	5000-5999	0.78	0.81	0.21	0.57
	6000-6999	1.11	1.12	1.18	1.13
	≥ 7000	1.16	1.66	6.07	3.04
	TOTAL	0.84	0.87	1.14	0.93

LPS = Length of Permanent Stream; LIS = Length of Intermittent Stream; LRM = Length of Rimrock; LRD = Length of Major Ridge. All distances are in kilometers.

the distinctive geology of McDermitt Caldera. However, when all elevations are compared by drainage, the difference in frequency of springs between drainages is not great.

In summary, the strongest patterns revealed by this analysis of the environmental variables within the TCOCU are as follows. As one proceeds from the lower to the higher elevations, intermittent streams become much less common, permanent streams tend to increase slightly, and rimrock, ridgeline and springs increase substantially. A major exception in the north drainage is an actual tendency for rimrock to decline at the higher elevations, owing to the unique physiography of the tilted fault block.

DESCRIPTION OF SURVEYED QUADRATS

Before detailing the results of the cultural resource survey of the TCOCU project area, it would be useful to expound on the setting of the survey. The purpose of the following section is to present an overview of the physiography of the survey quadrats as revealed by our survey; Appendix A describes the physiographic setting of each individual survey quadrat, while the survey quadrat maps are presented in Appendix B. The specific, quantified, environmental variables of the quadrats selected for survey have previously been presented in Table 4.4.

The TCOCU project area is a land of similarities and contrasts. The most obvious contrast is the topographic diversity found within the project area, with the terrain ranging from flat or gently sloping with little topographic relief (Figure 5.1), to extremely rugged, broken terrain, with steep slopes, narrow, deep canyons, abundant rimrock (Figure 5.2), and ridges ranging from sharp and narrow to broad and flat. This topographic variability is reflected by the elevational differences within each individual survey quadrat; these differences range from a low of 60 feet to a high of 1090 feet. The amount of relief (and the degree of ruggedness) is related to overall elevation, as the quadrats in the lower elevations generally are less steep and broken: the mean elevation range within individual survey quadrats between 4000 and 5000 feet is 143.3 feet; between 5000 and 6000 feet it is 332.9 feet; between 6000 and 7000 feet it is 544.5 feet, and above 7000 it is 490.0 feet. The decrease in elevational range for quadrats above 7000 feet results from the broad, flat ridges common at the highest elevations. This pattern is true for all the drainages.

As mentioned, ridges range from broad and relatively flat, to sharp and narrow. In general, the break from a ridge to steep slopes is marked by rimrock or frequent rock outcrops (Figure 5.3). The distribution of rimrock and frequent rock outcrops is interesting. Of the 36 quadrats surveyed, 22 (61.1%) have rimrock or frequent rock outcrops, with a definite correlation between the presence or absence of rock and elevation (as with elevational differences, the presence or absence of rock does not vary greatly between drainages). Three of the four (75%, or 91.6% when normed to acreage) quadrats above 7000 feet and all of the quadrats between 6000 and 7000 feet have

Figure 5.1. Physiographic Setting with Low Slopes.

Figure 5.2. Physiographic Setting with Broken Terrain and Steep Slopes.

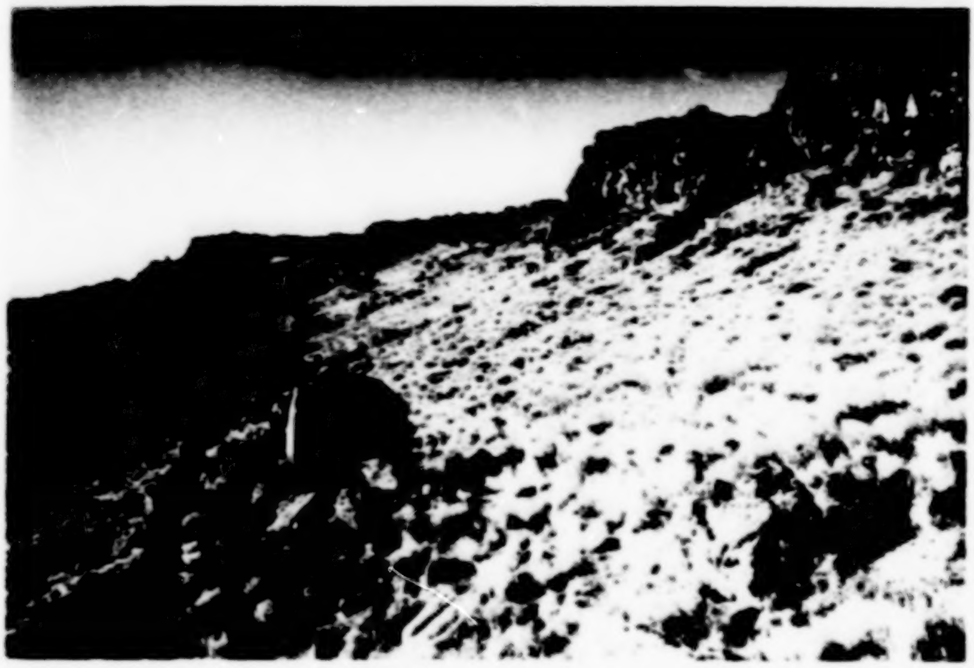

Figure 5.3. Physiographic Setting with Rimrock.

rimrock, while 46.6% of the quadrats between 5000 and 6000 feet and only 16.6% of the quadrats below 5000 feet have rimrock.

The topography in the lower portions of the McDermitt Caldera deserves a special mention, as it is generally different from the sharply broken terrain found in the higher elevations, or the relatively flat ground with little relief found in the lower elevations of the remainder of the project area. Instead, the terrain is more rolling, often with substantial relief, but with the break between ridges and slopes not marked by rimrock, and the slopes not as steep as elsewhere. This is not true of the sides of the caldera, or near McDermitt Creek, where the terrain is similar to the remainder of the project area.

Twelve of the 36 surveyed quadrats contain permanent water sources. The water source in five of these quadrats is a creek (such as McDermitt Creek, shown in Figure 5.4), four are springs, and three quadrats have both springs and creeks. In addition, two of the quadrats have sizable creek beds (and show as permanent creeks on USGS maps), but had no water at the time of the survey. The presence of a permanent water source varies with both elevation and drainage. When normed to acreage, 58.3% of the survey area above 7000 feet has a permanent water source, as does 47.6% of the area between 6000 and 7000 feet, 22.2% of the area between 5000 and 6000 feet, and 29.4% of the area below 5000 feet. In the southern drainage, 44.4% of the surveyed area has a

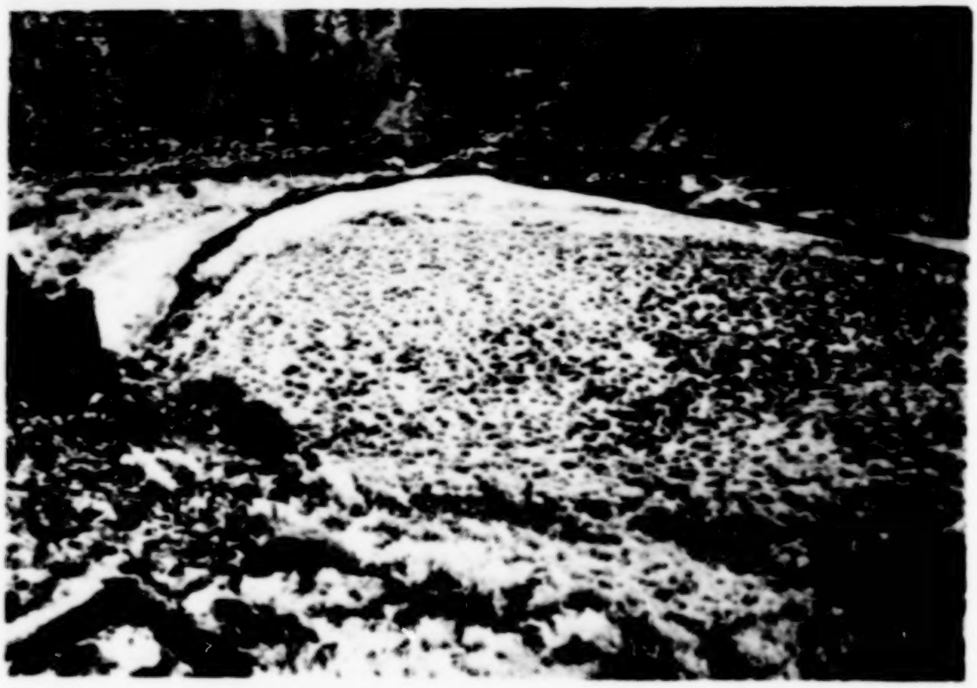

Figure 5.4. Physiographic Setting with a Major Stream (McDermitt Creek).

water source, while 37.7% of the surveyed area in the northern drainages, and only 22.2% of the surveyed area in the eastern drainages, has a water source.

While the topography is diverse, the vegetation is, in general, similar throughout (compare figures 5.1-5.4), with sagebrush the predominant flora (in all quadrats), and grasses also found in all quadrats. The sagebrush and grass range from low to tall, and from sparse to dense, depending upon topographic position. On ridgetops, the sagebrush and grass are characteristically low (from 10 to 50 cm) and sparse, with the density and height increasing on slopes (particularly on the leeward sides of ridges), protected benches, and canyon bottoms. In some of the canyon bottoms, particularly along streams, the sagebrush reaches heights of over 2.0 m, and is so dense that we occasionally had to crawl through the thickets.

Sagebrush and grass are by no means the only types of vegetation present in the project area. Rabbitbrush is common, particularly in more protected areas. Quaking aspen was observed in several of the quadrats, and ranged from stands of small, shrub-like thickets (which were extremely difficult to walk through) to single, or groves of, tall trees. The tall trees are situated in or near drainage bottoms with water nearby, while the thickets are on protected slopes or benches. Mountain mahogany was also observed in several quadrats, ranging from single trees to thick stands. Unlike the quaking aspen, mountain mahogany is located in the more exposed areas, such as broad, flat ridges, where it develops a characteristic wind-swept appearance. Willow is common along most of the permanent streams. Of special interest is a single juniper tree, observed in quadrat 40-38-1-NE at an elevation of approximately 6100 feet (it is located in a protected area on the leeward side of rimrock, just below a wind-swept ridgetop), and a single pine tree (species unknown), situated near Little Antelope Creek at an elevation of approximately 5500 feet, just east of quadrat 37-37-13-SW. No other trees of these kinds were observed in or even close to the project area.

Like vegetation, the soils within the project area are consistent throughout the project area. The basic sediment is a gravelly silty loam, with the exception of alluvial silts found adjacent to the larger streams in the lower elevations. As a general rule, the soil on the ridgetops is very deflated, creating a "desert pavement" of almost pure gravels, or is exposed bedrock. On more protected, relatively flat areas, the soil ranges from semi-deflated to non-deflated. On steep slopes, where the deposition is primarily colluvial, the sediments are either very gravelly, or are talus.

An interesting facet of the physiography of the project area is the presence of Whitehorse obsidian. Twelve of the 36 quadrats surveyed contained naturally occurring obsidian, ranging from small (1 - 3 cm), weathered nodules to larger (up to 20 cm) nodules in locations used aboriginally as raw material sources. The density of this natural obsidian is also variable, as some quadrats with natural obsidian only have a sparse scattering of nodules. Five of the recorded locations of obsidian are on ridges, while four are on slopes, and three are associated with drainages (either in the alluvial gravels, or near the bottoms of the drainages). There is a definite association between the presence of obsidian and elevation. When normed to acreage, 91.6% of the area surveyed over 7000 feet, 54.8% of the area between 6000 and 7000 feet, and 16.6% of the area between 5000 and 6000 feet has obsidian, which is absent from all of the surveyed quadrats under 5000 feet. It is interesting that drainage appears not to be a factor in obsidian location, though in McDermitt Caldera the only obsidian seen appears to have been alluvially deposited. It should be noted also that natural CCS was present within the caldera.

CULTURAL RESOURCE SITES

Seventy-eight archaeological sites were documented by IRI within the TCOCU project area. Table 5.2 lists the attributes of the individual sites. The majority (57, or 73%) of the sites are lithic scatters, while 13 (17%) are rock features, six (8%) are rockshelters, and two (2%) are aboriginally utilized obsidian sources. All but the 13 rock features are prehistoric sites (with a temporal range between 7000 BP and Euro-American contact; this is discussed in detail below); two of the rock features are clearly historic rock wall sites, while the remaining 11 rock features are mostly cairns, probably historic. If only the obviously prehistoric sites are considered, the site density for the 5000 acre project area is 13 sites per 1000 acres; if all the sites are considered, the density is 16 sites per 1000 acres. The following discussion, and Table 5.2, refer to the sites by a trinomial system; these are BLM-assigned, temporary numbers in Smithsonian format.

Table 5.2. Description of Archaeological Sites Recorded by IRI in the TCOCU Project Area.

SITE NO.	SITE TYPE (*1)	SITE SIZE (m^2)	ELEV (ft)	SOIL (*2)	WATER SOURCE	DIST. TO WATER (m)	RAW MATERIAL (*3)	ARTIFACTS (*4)	FEATURES	DATE (BP)
ML5300	OS	54000	7680	D	INT. CREEK	500	99% OBS 1% CCS	MDD = 5000; 1 GSS; = 50 biface fragments, worked & battered flakes.	NONE	5000-2500
ML5301	LS	370	7540	SD	INT. CREEK	90	100% OBS	MDD = 10; 1 BIFACE	NONE	?
ML5302	LS	13500	7740	D	INT. CREEK	500	99% OBS 1% CCS	MDD = 30; NO TOOLS	NONE	?
ML5303	LS	6300	7700	D	INT. CREEK	400	100% OBS	MDD = 17; NO TOOLS	NONE	?
ML5304	LS	41400	7680	D	INT. CREEK	240	100% OBS	MDD = 50; NO TOOLS	NONE	?
ML5305	LS	36	7800	D	NONE	0	100% OBS	MDD = 15; 1 PP FRAG	NONE	?
ML5306	LS	200	7840	D	NONE	0	99% OBS 1% CCS	MDD = 50; NO TOOLS	NONE	?
ML5307	LS	54000	7820	D	INT. CREEK	240	100% OBS	MDD = 200; 3 BIFACES	NONE	?
ML5308	LS	7200	7160	SL	STREAM	150	100% OBS	MDD = 10; 2 BIFACES	NONE	?
ML5309	LS	150	6120	D	STREAM	420	100% OBS	MDD = 18; 2 PP FRAGS	NONE	?
ML5310	LS	2800	6620	D	STREAM	120	99% OBS 1% CCS	MDD = 50; NO TOOLS	NONE	?
ML5311	RS	30	6600	SL	STREAM	120	100% OBS	MDD = 6; NO TOOLS	NONE	?
ML5312	RS	60	6600	SL	STREAM	120	99% OBS 1% CCS	MDD = 30; 1 MORTAR; FAUNAL REMAINS; CARBON	HEARTH (?)	?
ML5313	LS	225	7720	D	INT. CREEK	500	100% OBS	MDD = 30; NO TOOLS	NONE	?
ML5314	LS	5400	7700	D	INT. CREEK	500	100% OBS	MDD = 40; NO TOOLS	NONE	?
ML5315	RF	100	4760	T	STREAM	100		NONE	2 ROCK RETAINING WALLS	HIST.
ML5316	LS	15000	4760	AS	STREAM	40	99% OBS 1% CCS	MDD = 40; FAUNAL REMAINS; 1 HG; 1 ECN; 1 GSS; 1 GCS	NONE	5000-200
ML5317	RF	3	4780	T	STREAM	80	NONE	NONE	1 ROCK WALL	HIST.
ML5318	LS	700	5610	SL	INT. CREEK	420	100% OBS	MDD = 31; NO TOOLS	NONE	?
ML5319	LS	75	6220	D	INT. CREEK	370	100% BAS	MDD = 100; NO TOOLS	NONE	?
ML5320	LS	12800	5540	SL	INT. CREEK	70	90% OBS 10% CCS	MDD = 50; 8 BIFACES	BIFACE CACHE (?)	?
ML5321	LS	9	5470	D	INT. CREEK	180	100% OBS	MDD = 24; NO TOOLS	NONE	?
ML5322	LS	11700	5460	D	INT. CREEK	20	100% OBS	MDD = 38; 1 PP	NONE	?
ML5323	LS	26100	5460	SD	INT. CREEK	45	90% OBS 10% CCS	MDD = 100; 1 GSS	NONE	5000-2500
ML5324	RF	1	6460	D	NONE	0	NONE	NONE	1 ROCK CAIRN	?
ML5325	RF	4	6540	D	NONE	0	NONE	NONE	1 ROCK RING, 2 m DIA.	?
ML5326	LS	2700	5500	SD	INT. CREEK	90	90% OBS 10% CCS	MDD = 200; 1 E	NONE	5000-1000
ML5327	LS	12600	5540	SD	INT. CREEK	270	99% CCS 1% OBS	MDD = 100; NO TOOLS	NONE	?
ML5328	LS	2700	5610	SD	INT. CREEK	300	100% CCS	MDD = 50; NO TOOLS	NONE	?

Table 5.2. (Continued)

ML5329	LS	5400	5560	SL	INT. CREEK	40	90% OBS 10% CCS	MDD = 60; 1 BIFACE; 1 HCB; 1 RG	NONE	6000-200
ML5330	RF	1	6480	T	STREAM	200	NONE	NONE	1 ROCK CAIRN	?
ML5331	RF	1	6080	T	STREAM	500	NONE	NONE	1 ROCK CAIRN	?
ML5332	RF	1	6380	T	STREAM	500	NONE	NONE	1 ROCK CAIRN	?
ML5333	LS	5800	6760	SL	NONE	0	99% OBS 1% CCS	MDD = 1000; NO TOOLS	NONE	?
ML5334	LS	1500	5260	SL	INT SPRING	180	90% OBS 10% CCS	MDD = 100; NO TOOLS	NONE	?
ML5335	LS	4500	6570	SD	SPRING	150	100% OBS	MDD = 1000; NO TOOLS	NONE	?
ML5336	LS	5400	6570	SD	SPRING	150	100% OBS	MDD = 20; NO TOOLS	NONE	?
ML5337	LS	6300	6570	D	STREAM	400	100% OBS	MDD = 200; 3 BIFACES	NONE	?
ML5338	LS	2700	5170	SD	INT. CREEK	40	99% OBS 1% CCS	MDD = 25; NO TOOLS	NONE	?
ML5339	RF	1	5200	D	INT. CREEK	15	NONE	NONE	1 ROCK CAIRN	?
ML5340	RF	1	5500	D	NONE	0	NONE	NONE	1 ROCK CAIRN	?
ML5341	RF	2	5450	D	NONE	0	NONE	NONE	1 ROCK CAIRN	?
ML5342	RF	2	5520	D	NONE	0	NONE	NONE	1 ROCK CAIRN	?
ML5343	RF	30	5360	D	INT. CREEK	15	NONE	NONE	2 ROCK CAIRNS, 15 m APART	?
ML5344	OS	1800	6370	SL	NONE	0	100% OBS	MDD = 200; NO TOOLS	NONE	?
ML5345	LS	4500	6370	D	INT. CREEK	20	90% OBS 10% CCS	MDD = 30; 1 BIFACE	NONE	?
ML5346	LS	100	6395	SD	INT SPRING	30	100% OBS	MDD = 30; 1 BIFACE	NONE	?
ML5347	LS	2700	6460	SL	INT. CREEK	250	99% OBS 1% CCS	MDD = 50; NO TOOLS	NONE	?
ML5348	LS	1500	6490	SD	STREAM	300	100% OBS	MDD = 20; 1 EE	NONE	4000-1000
ML5349	LS	4800	6490	D	STREAM	175	100% OBS	MDD = 20; NO TOOLS	NONE	?
ML5350	LS	2000	5270	SD	INT. CREEK	30	98% OBS 1% CCS 1% BAS	MDD = 35; 1 BIFACE; 2 RG, 1 ECN, 1 HCB	NONE	6000-200
ML5351	RF	1	5200	D	INT. CREEK	15	NONE	NONE	1 ROCK CAIRN	?
ML5352	LS	1350	5185	SD	INT. CREEK	90	99% OBS 1% CCS	MDD = 10; NO TOOLS	NONE	?
ML5353	LS	3000	5200	SD	INT. CREEK	150	99% OBS 1% CCS	MDD = 26; NO TOOLS	NONE	?
ML5354	RS	3	5495	SL	STREAM	200	OBS CCS	MDD = 12; FAUNAL REMAINS; NO TOOLS	NONE	?
ML5355	RS	14	5900	SL	INT. CREEK	180	90% OBS 10% CCS	MDD = 20; FAUNAL REMAINS; NO TOOLS	NONE	?
ML5356	LS	450	5950	D	INT. CREEK	30	98% OBS 2% CCS	MDD = 10+; NO TOOLS	NONE	?

Table 5.2. (Continued)

ML5357	RS	22	5900	SL	INT. CREEK	60	75% OBS 25% CCS	MDD = 10+; 1 HCB; 1 CORE; 2 ABRADERS; 1 INCISED STONE; 1 ES; 1 BIFACE ; FAUNAL REMAINS; CARBON	NONE	6000-3000
ML5358	LS	1800	5790	SL	INT. CREEK	200	99% OBS 1% CCS	MDD = 15; NO TOOLS	NONE	?
ML5359	LS	625	5730	SL	INT. CREEK	50	100% OBS	MDD = 10+; 1 RG	NONE	2000-200
ML5360	LS	8100	5740	SL	INT. CREEK	5	98% OBS 2% CCS	MDD = 50; 1 BIFACE; 1 HCB; 1 GSS	NONE	7000-2500
ML5361	LS	300	5500	D	STREAM	300	99% OBS 1% CCS	MDD = 30; NO TOOLS	NONE	?
ML5362	LS	1800	5540	SD	INT. CREEK	150	100% OBS	MDD = 29; NO TOOLS	NONE	?
ML5363	LS	225	5500	SD	INT. CREEK	240	100% OBS	MDD = 12; NO TOOLS	NONE	?
ML5364	LS	225	5500	SD	INT. CREEK	270	100% OBS	MDD = 13; NO TOOLS	NONE	?
ML5365	LS	225	5480	SL	INT. CREEK	180	100% CCS	MDD = 13; NO TOOLS	NONE	?
HA5100	LS	400	6000	SD	INT. CREEK	30	100% OBS	MDD = 10+; NO TOOLS	NONE	?
HA5101	LS	100	6370	D	INT. CREEK	500	100% OBS	MDD = 12; 1 BIFACE; 1 ES	NONE	?
HA5102	LS	150	6330	D	INT. CREEK	350	100% OBS	MDD = 10+; NO TOOLS	NONE	?
HA5103	RS	33	4660	SL	INT. CREEK	175	80% OBS 20% CCS	MDD = 15; 1 PP; 1 SHARPENED STICK; FCR; FAUNAL REMAINS; CARBON	HEARTH	?
HA5104	LS	900	4740	SD	STREAM	360	80% OBS 20% BAS	MDD = 100; NO TOOLS	NONE	?
HA5105	LS	43200	4700	AS	STREAM	30	99% OBS 1% CCS	MDD = 75; 2 BIFACES; 1 LSN; 1 HCB; 1 ECN	NONE	7000-1000
HA5106	LS	[illegible]	4690	SL	STREAM	100	98% OBS 1% CCS 1% BAS	MDD = 20; NO TOOLS	NONE	?
HA5107	LS	500	4710	SL	STREAM	200	99% OBS 1% BAS	MDD = 30; NO TOOLS	NONE	?
HA5108	LS	1200	4730	SL	STREAM	120	100% OBS	MDD = 15; NO TOOLS	NONE	?
HA5109	LS	2700	4750	SL	STREAM	120	95% OBS 5% BAS	MDD = 30; 1 CORE	NONE	?
HA5110	LS	9900	4720	SL	STREAM	15	50% OBS 50% BAS	MDD = 50; NO TOOLS	NONE	?
HA5111	LS	152	5670	D	INT. CREEK	450	100% OBS	MDD = 15; NO TOOLS	NONE	?

KEY

*1: LS = Lithic Scatter; OS = Obsidian Source; RS = Rockshelter; RF = Rock Feature
*2: SL = Silty or Sandy Loam; D = Deflated Surface ("Desert Pavement"); SD = Semi-deflated Surface; T = Talus; AS = Alluvial Silt
*3: OBS = Obsidian; CCS = Cryptocrystalline Silica; BAS = Basalt
*4: MDD = Maximum Debitage Density per 100 m^2; PP = unidentifiable Projectile Point; RG = Rosegate; ECN = Elko Corner-notched; EE = Elko Eared; E = Undifferentiated Elko series; GSS = Gatecliff Split Stem; GCS = Gatecliff Contracting Stem; HCB = Humbolt Concave Base; LSN = Large Side-notched; ES = End Scraper; FCR = Fire-cracked Rock

The 57 lithic scatters are concentrations of lithic debitage, with densities equal to or exceeding 10 items per 100 m^2 (see discussion under Field Methods, above). Sites of this type range in size from 9 m^2 to 54,000 m^2. The maximum densities of lithic debitage range from 10 to 1000 specimens per 100 m^2; the debitage in 53 (93%) of the lithic scatters is entirely or primarily obsidian, while the debitage in three of the sites is primarily CCS, the debitage in one site is comprised half of obsidian and half of basalt, and all of the debitage in one site is basalt. The most common tool types observed were projectile points and other bifaces, with a core and an end scraper also observed. No features were observed in these sites, with the possible exception of 35ML5320, which had what appeared to be a biface cache. Most (38, or 67%) of the lithic scatters are situated on deflated or semi-deflated surfaces, indicating little or no subsurface deposits. Two of the sites (35ML5316 and 35HA5105) are on alluvial silts, so the chances of subsurface site manifestations are high; the likelihood of subsurface deposits in the remaining lithic scatters is unknown. The integrity of these sites is generally good. Impacts have been mainly from cattle grazing (possibly resulting in damage to the lithic debitage), and from illicit surface collection.

The rock feature sites include nine single rock cairn sites (Figure 5.5), a site with two cairns, two rock wall sites, and one rock ring site. These sites range in size from 1 to 100 m^2, with none of the single cairn sites or the rock ring site larger than 4 m^2. None of the rock features contained associated cultural debris, with the possible exception of one of the rock wall sites (35ML5315) and two of the rock cairns. The rock wall site consists of two separate rock alignments, each situated at the toe of a talus slope, and appearing to have functioned as retaining walls to keep scree off a now old, abandoned road. One of the rock walls is 8.0 m long and 80 cm high; the second wall is 3.8 m long and 90 cm high (Figure 5.6), and is 12 m northeast of the first rock wall. Construction is simply stacked tabular scree debris. Cultural debris in the site area (but not necessarily associated with the walls) consists of two 3" x 8" planed wooden beams, and several oil filters. The second rock wall site (35ML5317, measuring 5.9 m long and approximately 60 cm high) is also associated with the old road, but runs perpendicular to the road (up a talus slope) and thus did not serve as a retaining wall (the function is unknown, but it may at one time served as a fence). One of the two cairns mentioned above (35ML5332) contained an inscription written on a flat aluminum piece placed within the cairn and probably denoting a mining claim. The other cairn (35ML5330) contained a pink ribbon which may or may not have been placed there when the cairn was constructed. It seems probable that most or all of the cairns mark old mining claims, which in modern times are marked by upright PVC pipes observed commonly in the southern and eastern portions of the project area. The rock ring site (35ML5325) consists of a small U-shaped enclosure 2 by 1.5 m, and a maximum of only 50 cm high. No obvious function is apparent, and it may be either prehistoric or historic. As a general rule, the rock feature sites are associated with deflated, rocky surfaces or with talus slopes. The integrity of the rock features is good, although one of the cairns may be partially collapsed.

The six rockshelters observed during the survey are very interesting, as all appear to be well preserved. With the possible exception of surface

Figure 5.5. Typical Rock Cairn (35ML5324, to Northeast).

Figure 5.6. Rock Wall (35ML5325, Feature 2, to North).

collection, none of these sites appear vandalized. Cattle have used all the shelters, disturbing the surface of the sites. However, all appear to have subsurface deposits, and thus offer excellent research potential. Figures 5.7 through 5.9 illustrate three of the rockshelters.

The rockshelter sites range in size from 3 to 60 m², with lithic densities ranging from 6 to 30 items per 100 m². The raw material on the surface at each of these sites is primarily obsidian, although CCS was seen in all but one. Tools observed within the shelters include projectile points, a biface, a possible mortar, a core, two abraders, an incised stone, an end scraper, and, in 35HA5103, a perishable item (a sharpened stick). Site 35HA5103 (Figure 5.9) also has what appears to be a hearth feature, with charcoal fragments and fire-cracked rock. None of the other rockshelters have features, although 35ML5312 has a smoke-stained wall. Charred faunal remains were observed in five of the rockshelters.

The remaining two sites observed during our survey are obsidian sources which were aboriginally exploited for raw materials. Each is characterized by high densities of obsidian lithic debitage (up to 5000 items per 100 m² at 35ML5300, and 200 items per 100 m² at 35ML5344), and obsidian nodules large enough to be utilized for tool extraction. (As discussed previously, naturally occurring obsidian is plentiful throughout the project area, and was observed in numerous sites, but in nodules that were too small to be very useful). The size of the obsidian source sites is extremely variable, with 35ML5300 larger than 54,000 m² (the site extends significantly outside the

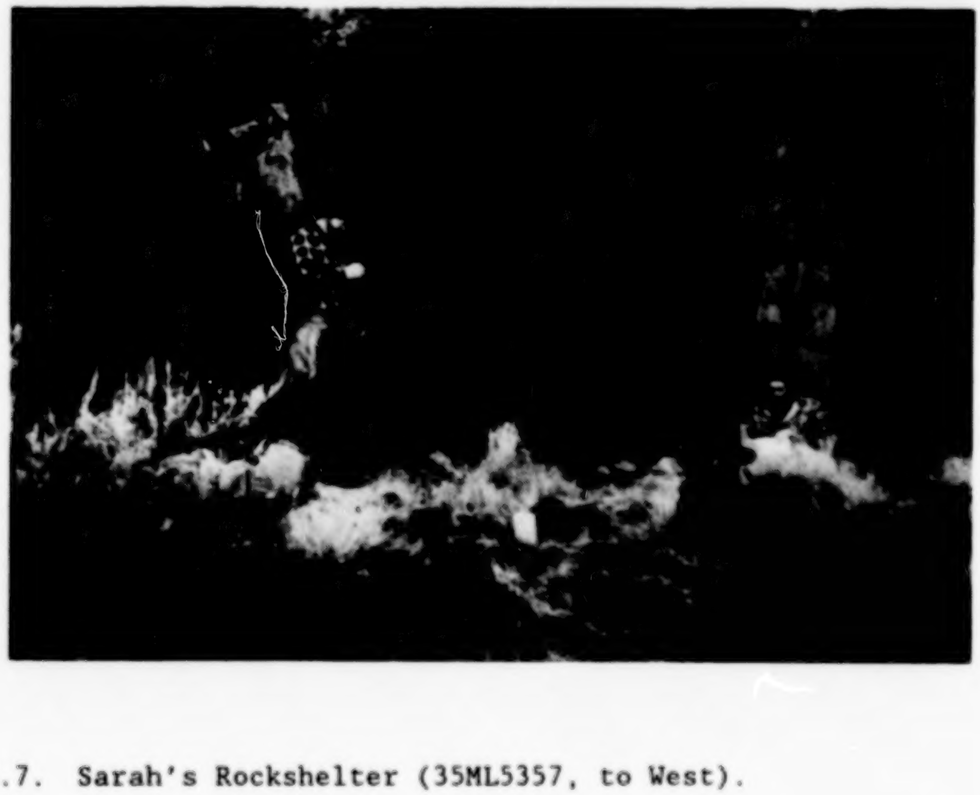

Figure 5.7. Sarah's Rockshelter (35ML5357, to West).

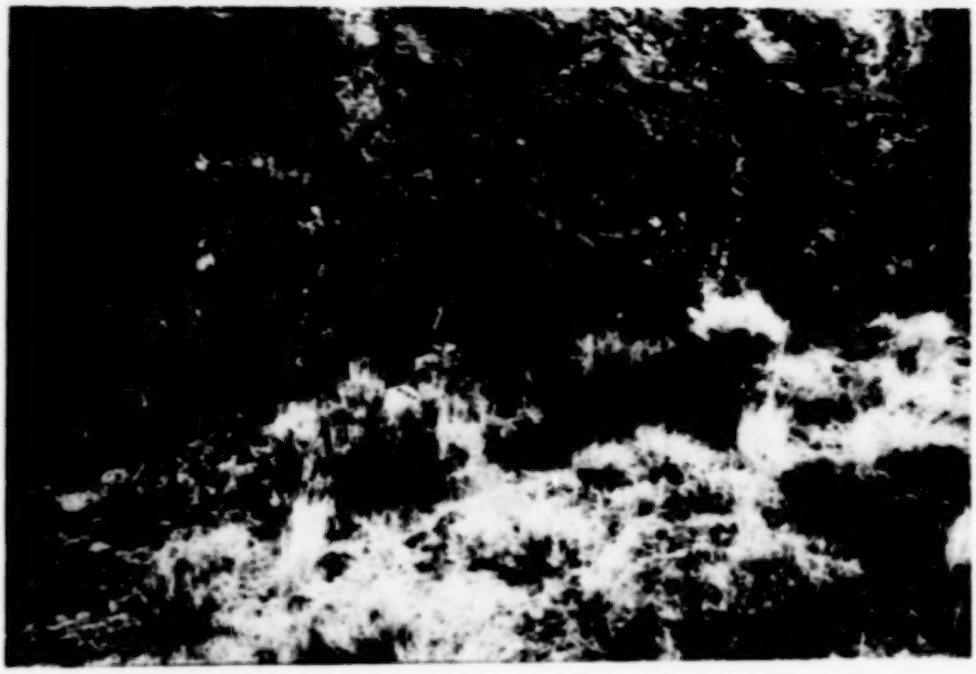

Figure 5.8. Pinnacle Cave (35ML53[illegible]5, to North).

Figure 5.9. The Tube Rockshelter (35HA5103, to West).

survey quadrat, and the western site boundary was never determined), and 35ML5344 only 1800 m². Site 35ML5300 contains numerous biface fragments and worked and battered flakes, while no tools were observed at 35ML5344. No features were observed in either site, and neither site appears to have any significant subsurface deposits.

Because one of the goals of this research project is to determine prehistoric land-use patterns and their relationship with environmental variables, it would be useful here to examine the physiographic setting of the sites recorded in the TCOCU project area. Table 5.3 shows the frequency of all the sites by drainage and elevational range (both as defined for our sampling strata) for the entire project area. As can be seen, the highest elevation range (over 7000 feet) for the project area as a unit has the highest frequency of sites, while the lower elevation intervals are fairly similar. Interestingly, however, the north drainage does not follow this pattern, but in fact has the second lowest frequency of sites for any of the sampling strata. The south drainage has the highest overall site frequency, with the north drainage the lowest.

When the distribution of sites by type is examined, it is no surprise that the frequency of all sites is mirrored by the frequency of lithic scatters (Table 5.4), but the distribution of rockshelters and rock features differs. Rockshelters (keep in mind the small sample size of six) are absent in the south drainage, and most common in the east; the highest elevation has no rockshelters, while the frequencies for the remaining elevation intervals are almost identical. This elevational distribution is similar for rock features, although sites of this type are by far most frequent in the south drainage (where mining activity has been greatest), and are absent in the east drainage.

Obsidian source sites are not included in Table 5.4, because only two sites of this type were recorded. One of these is in the south drainage above 7000 feet, while the second obsidian source site is in the east drainage, in the 6000-6999 feet elevation range.

It is also possible to make some gross characterizations of sites as they relate to specific environmental settings (derived from site records, not the geographic database). One of the more interesting correlations between site locations and the environmental setting is the distance to water (tables 5.5 and 5.6). When all the sites are included, the distance to water increases with increasing elevation for the project area as a unit, with only the highest elevation in the north drainage reversing this trend. However, when examined by site type, the same pattern holds true for lithic scatters, but is reversed for rockshelters, where the distance to water decreases somewhat (but probably not significantly) with increasing elevation. This is what one might expect if the rockshelters were used as base camps, and the lithic scatters were resource exploitation sites visited on day trips.

The correlation of site frequency with topographic setting is also interesting (Table 5.7). More sites are located on top of ridges than any other topographic feature, though no sites were found on top of ridges in the lowest elevation interval. Conversely, sites on terraces are confined to

Table 5.3. Frequency of Sites by Drainage and Elevation. Frequency is expressed as sites per 1000 acres.

ELEVATION RANGE	DRAINAGE			
	NORTH	EAST	SOUTH	TOTAL
< 5000	18.2	0.0	7.5	16.2
5000-5999	14.1	10.3	20.2	15.3
6000-6999	10.0	20.5	13.6	13.7
≥ 7000	4.2	41.7	41.7	22.9
TOTAL	12.3	14.6	21.5	15.6

Table 5.4. Frequency of Sites by Site Type, Elevation, and Drainage. Frequency is expressed as sites per 1000 acres

ELEVATION RANGE	LITHIC SCATTERS				ROCKSHELTERS				ROCK FEATURES			
	drainage				drainage				drainage			
	NO	EA	SO	TTL	NO	EA	SO	TTL	NO	EA	SO	TTL
< 5000	15.9	0.0	25.0	11.8	2.3	0.0	0.0	1.5	0.0	0.0	50.0	2.9
5000-5999	10.9	5.9	15.5	11.1	0.0	4.4	0.0	1.4	3.1	0.0	4.8	2.8
6000-6999	7.5	18.2	2.3	8.9	2.5	0.0	0.0	1.2	0.0	0.0	11.4	3.0
≥ 7000	4.2	41.7	33.3	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	9.9	11.8	13.2	11.4	1.4	2.1	0.0	1.2	0.9	0.0	7.6	2.6

Abbreviations: NO - North drainage; EA - East drainage; SO - South Drainage; TTL - Total.

Table 5.5. Mean distance from Sites to Water (in Meters). Sites without water sources are excluded; permanent springs, permanent streams, and intermittent streams are included.

ELEVATION RANGE	DRAINAGE			
	NORTH	EAST	SOUTH	TOTAL
< 5000	140	0	73	122
5000-5999	113	140	164	130
6000-6999	208	164	392	205
≥ 7000	150	294	500	347
TOTAL	152	187	232	195

Table 5.6. Mean Distance from Sites to Water (in Meters), by Site Type. The same parameters apply for Table 5.7.

ELEVATION RANGE	LITHIC SCATTERS				ROCKSHELTERS				ROCK FEATURES			
	drainage				drainage				drainage			
	NO	EA	SO	TTL	NO	EA	SO	TTL	NO	EA	SO	TTL
< 5000	135	0	40	123	175	0	0	175	0	0	90	90
5000-5999	141	135	175	158	0	147	0	147	15	0	15	15
6000-6999	284	184	370	233	120	0	0	120	0	0	400	400
≥ 7000	150	294	500	328	0	0	0	0	0	0	0	0
TOTAL	175	205	217	198	138	147	0	142	15	0	232	178

Abbreviations: NO = North drainage; EA = East drainage; SO = South Drainage; TTL = Total.

Table 5.7. Topographic Setting of Sites by Drainage and Elevation. Frequency is expressed as sites per 1000 acres.

TOPOGRAPHIC SETTING	ELEVATION RANGE	NORTH	EAST	SOUTH	TOTAL
Terrace	< 5000	9.1	0.0	25.0	7.3
	5000-5999	1.6	0.0	4.8	2.3
	6000-6999	0.0	0.0	0.0	0.0
	≥ 7000	0.0	0.0	0.0	0.0
	TOTAL	2.4	0.0	3.5	2.0
Ridgetop	< 5000	0.0	0.0	0.0	0.0
	5000-5999	9.4	2.9	9.5	7.4
	6000-6999	3.8	6.8	6.8	5.4
	≥ 7000	0.0	33.3	8.3	6.0
	TOTAL	4.2	6.3	8.3	6.0
Top of Rimrock	< 5000	0.0	0.0	0.0	0.0
	5000-5999	1.6	0.0	1.2	0.9
	6000-6999	2.5	6.8	0.0	1.4
	≥ 7000	0.0	0.0	33.3	8.3
	TOTAL	1.4	2.1	3.5	2.2
Base of Rimrock	< 5000	2.3	0.0	25.0	2.9
	5000-5999	0.0	4.4	0.0	1.4
	6000-6999	2.5	0.0	2.3	1.8
	≥ 7000	0.0	0.0	0.0	0.0
	TOTAL	1.4	2.1	1.4	1.6
Canyon Slope	< 5000	0.0	0.0	0.0	0.0
	5000-5999	0.0	0.0	3.5	1.4
	6000-6999	0.0	4.5	0.0	1.2
	≥ 7000	0.0	8.3	0.0	2.1
	TOTAL	0.0	2.1	2.1	1.2

Note: Other topographic features (not included here due to the low number of sites recorded on these features) include talus slopes (0.6 sites), benches (0.6 sites), adjacent to ephemeral streams (0.4 sites), rolling plain with no other distinguishing features (0.4 sites), and at the toe of a canyon, with no other distinguishing features (0.2 sites).

the two lower elevational intervals. Sites situated on top of rimrock are most frequent at the higher elevations, while sites at the base of rimrock are absent from the highest elevational interval, and are more apt to be at the lower elevations. Sites situated on the sides of canyons (without other distinguishing topographic features such as rimrock) are fairly evenly distributed through all elevation ranges, except the lowest interval, where they are absent. As would be expected, the relationship of sites to topography is closely related to the overall project area topography (discussed above), with ridges and rimrock more common at the upper elevations, and terraces only at the lower elevations. The different drainages follow the same general patterns, with the exceptions that no sites were recorded on terraces in the east drainage, and no sites were recorded on canyon slopes in the north drainage.

The six undisturbed rockshelters are of great interest, as these sites have the potential to make a significant contribution to our knowledge of the prehistory of southeastern Oregon in general, and the uplands in particular. For this reason, the physiographic setting of the rockshelters was examined specially in an effort to associate the sites with particular environmental variables. Perhaps significantly, five of the six recorded rockshelters are in topographically similar settings. These five sites are all between 5495 and 6500 feet in elevation, and are situated at the base of extensive stretches of rimrock which marks the break between ridgetops and the steep slopes into canyons. All of these five rockshelters are found on major ridges (defined as greater than or equal to 2.0 miles long). None of these sites are close to permanent water sources, with distances to water (in each case a permanent stream) ranging from 120 to 600 m, and all are considerably higher in elevation than the stream (with elevation differences ranging between 160 and 560 feet). Two of the rockshelters (Sarah's Rockshelter and Pinnacle Cave) are situated closer to intermittent streams than to permanent streams.

The remaining rockshelter (The Tube) is an anomaly in that it is at the base of a rock outcrop, placed mid-slope on a relatively small knoll which rises above an otherwise flat plain. The elevation of this site, 4660 feet, is much lower than the other rockshelters. The knoll is not part of any ridge system, although the nearest ridge is a major ridge, located 850 m east of the site. Like the other rockshelters, the distance to water is relatively great, as it is 600 m (and 100 feet difference in elevation) to a permanent stream, and 175 m (with 60 feet elevation difference) to an intermittent stream.

Based on the results of our survey, rockshelters at the higher elevations (above 5400 feet) are associated with rimrock which marks the break between a major ridge and the sides of steep canyons. At the lower elevations, the rockshelters are not directly associated with rimrock or major ridges. This factor of decreasing importance of ridges and rimrock with rockshelter location fits with the observed site distribution for all site types. Presence of a permanent water source nearby does not appear to be an important criterion for rockshelter location. This discussion, of course, needs to be tempered with the realization that our sample of rockshelters is small, particularly at the lower elevations. Rockshelters may well be located in other topographic settings. For instance, extensive rimrock can be found adjacent to the alluvial terraces along portions of the lower reaches of the permanent streams, but none of our survey quadrats sampled these areas (it is likely that rockshelters are present in these areas, and it is also likely that, due to increased accessibility, these shelters have been vandalized).

Examination of the frequency of sites by site type, topographic setting, elevation, and drainage reveals that the distribution of lithic scatters follows the pattern for all sites, as expected for its dominant proportion, except that no lithic scatters were recorded at the base of rimrock. Rock features are absent on terraces, but are present in relatively equal numbers on ridgetops, the top of rimrock, and the base of rimrock (a single rock feature was recorded on a canyon slope without other distinguishing topographic features). Rock features are also found in all elevation intervals. Rockshelters, as noted above, are confined almost exclusively to the base of rimrock. One of the two obsidian sources is situated on top of rimrock, while the other is on a canyon slope, with no other distinguishing topographic features.

The patterns of site location discussed in this section provide a useful background for the analyses discussed below under "Associations of Cultural and Environmental Variables." Though sampling error is an important limitation, especially for rockshelters, rock features, and obsidian sources, some patterns stand out as probably meaningful. Lithic scatters are most frequent above 7000 feet, where herd animals, obsidian sources, and abundant water co-occur. Lithic scatters are farthest from water at the higher elevations, where water is generally more abundant (and thus possibly less of a determinant of site location); such sites also are likely to have been used on day trips rather than as bivouac locations. Rock features are most common by far in the south drainage area, where historic mining has been most active. Many of the other patterns appear to be the results of topographic constraints.

OTHER QUANTITATIVE AND QUALITATIVE RESULTS

Though the greater part of the cultural debris and features found during the field survey were within localities recorded as sites, the data recovered, both within and outside of these sites, can be described and summarized in other terms. Many cultural items were recorded (see Appendix B), and some collected, in off-site areas. Furthermore, provenience by site frequently has no bearing on analysis of data patterns. Since one of the main goals of the project was to find relationships between environmental variables and evidence of cultural land use, the survey quadrat, the basic analytical division, classified in terms of environmental variables and its likelihood of prehistoric land use, is the best unit of comparison for this purpose. Accordingly, the recovered data are summarized here in terms of the quadrats where they were found, and in terms of other variables not related to sites.

Table 5.8 is a comprehensive summary of data collected during the survey, arranged by quadrat and sampling stratum. The site area for each quadrat

Table 5.8. Data Summary by Surveyed Quadrat.

Stratum	Quadrat	Prehist. Sites	Site Area (m^2)	Debitage	PP	OFB	Other	Total Prehist.	Rock Feat.	Hist. Items
NO7	40-38-21-NE	0	0	15	1	1	0	17	0	1
	39-40-27-NE	1	1,800	64	2	3	0	69	0	0
NO6	39-40-5-SE	1	4,900	281	2	1	0	284	0	0
	39-39-22-NE	1	150	40	3	0	0	43	0	0
	39-39-13-SW	3	990	94	1	1	1[1]	96	0	3
	38-39-23-SE	0	0	22	0	0	0	22	0	0
	40-38-1-NE	3	650	122	2	3	0	127	0	1
NO5	39-39-9-SW	3	10,525	415	7	2	0	424	0	0
	39-39-5-SW	3	7,050	322	1	1	0	324	2	5
	39-39-5-NW	0	0	41	2	0	0	43	0	0
	39-38-24-NE	1	152	151	1	3	0	155	0	4
NO4	38-38-15-SW	1	33	18	1	1	2[2]	22	0	0
	38-38-35-NE	0	0	158	0	4	0	162	0	1
	38-38-27-SE	7	58,450	2,051	3	2	1	2,057	0	0
EA7	40-40-12-NE	7	120,295	32,981	2	3[3]	1	32,987	0	23
EA6	38-40-11-NW	0	0	178	0	0	0	178	0	0
	38-40-19-NW	6	13,200	672	4	2	0	678	0	7
	38-40-20-SW	3	9,900	558	2	3	0	563	0	0
EA5	38-40-14-SE	0	0	101	0	0	0	101	0	0
	38-40-1-NW	1	900	82	1	0	0	83	0	2
	39-41-21-NE	1	2,000	54	6	0	0	60	0	8
	37-37-13-SW	3	487	37	2	2	5[4]	46	0	0
	37-37-14-SE	2	303	70	5	2	0	77	0	0
EA4	39-41-36-SE	0	0	1	0	0	0	1	0	1
	39-41-11-SW	0	0	4	0	0	0	4	0	1
SO7	40-41-7-NE	3	24,536	1,066	2	9	0	1,077	0	13
SO6	40-41-19-SE	0	0	5	0	0	0	5	5	4
	40-39-14-SE	0	0	15	3	1	0	19	0	0
	41-39-18-SW	0	0	16	3	0	0	19	0	1
SO5	41-40-11-SW	0	0	7	0	0	0	7	0	1
	41-41-1-SW	0	0	17	0	0	0	17	4	0
	40-40-21-NW	1	75	19	0	0	0	19	0	1
	41-39-12-SE	0	0	215	0	0	0	215	0	5
	41-39-5-SE	0	0	45	2	0	0	47	0	0
	40-40-25-SE	13	67,084	3,181	10	11	1	3,203	0	0
SO4	41-41-20-NW	1	7,500	77	5	0	0	83	2	0

Key: PP = Projectile Points   OFB = Other Formed Bifaces   Rock Feat. = Rock feature sites

[1] Possible mortar fragment in dry rockshelter (35ML5312)

[2] Includes sharpened stick in dry rockshelter (35HA5103)

[3] Ca. 50 OFB's observed but not recorded

[4] Includes core, two shaft abraders, and incised stone in dry rockshelter (35ML5357)

includes only the on-site area within the quadrat boundaries, not those portions of sites extending beyond the boundaries. Debitage counts consist of items observed (or estimated) on the walked transects, and, because the transects were at 30 m intervals, are likely to represent no more than 13% of the total number actually visible on the surface of the entire quadrat. The counts of projectile points are for those collected, some of which were on transects and some within site boundaries, as well as several undiagnostic point fragments that were not collected. The OFBs (Other Formed Bifaces) listed may include fragmentary projectile points (undistinguishable in the field from other kinds of bifaces) as well as preforms and other bifacially flaked items (not including cobble tools). As with debitage, the counts for historic items are for those seen on the walked transects.

Perhaps the most remarkable feature about the data displayed in Table 5.8 is the great divergence of results from one quadrat to another. Many quadrats contain no sites, but one has 13. Site area within quadrats that contain sites varies from 33 to 120,295 m^2. No quadrats contain absolutely no evidence of prehistoric use, but debitage counts range from 1 to a high of 32,981. Rock features are present in only four quadrats, but, interestingly, each quadrat with rock features has more than one. Historic items are often present, but only two quadrats produced more than ten items.

Evidence of historic (Euro-American) as compared with prehistoric use of the project area in these data is very slim, reflecting real differences between the two cultures in modes of exploitation. The small numbers for rock feature sites and items, however, mask other facts regarding historic use. Historic roads, which are common, do not appear in our data, and evidence of cattle was nearlv everywhere. Modern use of the project area (primarily grazing) appears to be significant, but does not leave much widespread evidence in the form of cultural debris.

The kinds of prehistoric cultural debris observed give the impression that use was limited to a relatively narrow range of activities, particularly hunting and lithic raw material processing. Most tools observed were bifacially flaked items, especially projectile points, presumably reflecting hunting activities. Lithic debitage was both widespread and concentrated in places, frequently associated with natural concentrations of obsidian or CCS. The only locations where more diverse activities are strongly indicated are the dry rockshelters, where the variety of tools tends to be great (including the only grinding tool found by the survey) despite very small samples of observed items. This is not to say, of course, that the open lithic concentrations did not witness a wide variety of specific tasks (Pettigrew 1983), but only that rockshelters may have possessed a wider array of functions. The topic of site function will be taken up and elaborated upon later in this chapter.

Some of the more important data collected by the project come from the collected projectile points, by which we hope to learn a great deal about temporal variability. Table 5.9 lists the projectile points by sampling stratum, survey quadrat, site, and point type, following the type definitions of Pettigrew (1985a). Type definitions are reproduced in Appendix C. Some specimens, largely because of breakage at the proximal end of the stem, were

Table 5.9. Projectile Points by Quadrat, Site and Type.

			Type												
Stratum	Quadrat	Site	LSN	HCB	GCS	GSS	E/G	E	EE	ECN	RG	UST	SSN	UNC	Total
NO7	40-38-21-NE	--												1	1
	39-40-27-NE	--				1			1						2
NO6	39-40-5-SE	--				1				1					2
	39-39-22-NE	--				1									1
	39-39-13-SW	--												1	1
	40-38-1-NE	--		1							1				2
NO5	39-39-9-SW	--		1		1	1			1					4
		35ML5359									1				1
		35ML5360		1		1									2
	39-39-5-SW	--											1		1
	39-39-5-NW	--			1	1									2
	39-38-24-NE								1						1
NO4	38-38-15-SW	35HA5103												1	1
	38-38-27-SE	35HA5105	1	1						1					3
EA7	40-40-12-NE	--				1									1
		35ML5300				1									1
EA6	38-40-19-NW	--					1	1					1		3
		35ML5348							1						1
	38-40-20-SW	--		1			1								2
EA5	38-40-1-NW	--										1			1
	39-41-21-NE	--				1									1
		35ML5350		1						1	2			1	5
	37-37-13-SW	35ML5357		1											1
	37-37-14-SE	--		1	1		1		1					1	5
SO7	40-41-7-NE	--												1	1
SO6	40-39-14-SE	--									1			2	3
	41-39-18-SW	--	1											2	3
SO5	41-39-5-SE	--	1											1	2
	40-40-25-SE	--			1		1	1						1	4
		35ML5322												1	1
		35ML5323				1								1	2
		35ML5326						1							1
		35ML5329		1							1				2
SO4	41-41-20-NW	35ML5316			1	1				1	1			1	5
Total			3	9	4	11	5	3	4	5	7	1	2	15	69
%*			5.56	16.67	7.41	20.37	9.26	5.56	7.41	9.26	12.96	1.85	3.70		

Key:

E/G = Indistinguishable Elko/Gatecliff

E = Undifferentiated ElkoUNC = Unclassifiable

* Percentage of classifiable population (n=54)

indistinguishable between the EE and the ECN types, and so were classified as generalized Elko (E) points. Still others, for similar reasons, were indistinguishable between the Elko and Gatecliff series, and were assigned to a hybrid group (E/G). Although Pettigrew (1985a) discriminates between three subtypes of the Rosegate points (RG), these were lumped here because of fragmentation and the rather small sample size. Nearly all points were fragmented in some way, most commonly by breakage of the tip or barbs. Only one specimen could be considered complete. Selected specimens of each type are illustrated in figures 5.10-5.12.

Of the classifiable projectile points (54 in all), the best represented type overall is GSS (Gatecliff Split Stem) with 11 (20.37%) specimens, followed by HCB (Humboldt Concave Base) with 9 (16.67%) and RG (Rosegate) with 7 (12.96%). The two largest temporal groups are the Gatecliff Series (GSS and GCS) with 15 (27.78%) and the Elko Series (E, EE and ECN) with 12 (22.22%) specimens. The temporal groups with the fewest specimens are LSN (Large Side Notched) with 3 (5.56%), SSN (Small Side-notched) with 2 (3.70%) specimens, and UST (Unstemmed Triangular) with 1 (1.85%). As we shall see later in this chapter, these typological data argue for a peak in land-use intensity during the latter part of the middle Archaic.

The natural obsidian found at many places throughout the TCOCU, and with which we became familiar during the field survey, is a distinctive, brown or black, opaque volcanic glass known as Whitehorse obsidian. All collected projectile points were classified macroscopically by gross raw material group, of which there are three: Whitehorse obsidian, other obsidian, and CCS. An item was grouped with other obsidian when it did not fit the standard Whitehorse class. Although misidentification is possible at this level, since some exotic obsidian may fit the Whitehorse definition and some Whitehorse obsidian might exhibit different macroscopic characteristics, little variability appeared in the natural obsidian deposits, and source identification using gross groups is likely to be quite accurate in this area. The results of correlating raw material with point type, shown in Table 5.10, do not contradict this assumption. The most striking pattern that emerges distinguishes the older and more numerous dart point population (ECN, EE, etc.) from the smaller and generally younger arrow points (SSN, UST, and RG). Two-thirds of the larger dart points are made of Whitehorse obsidian, one-third of other obsidian, and none of CCS, while the smaller and later styles are much less commonly made of Whitehorse obsidian, and much more frequently made of other obsidian and CCS. In fact, the only CCS points found in the project area all have narrow necks (8 mm or less) and belong to the latest types. Among the unclassifiable points, which follow the two-thirds/one-third pattern exactly, none appear small or delicate enough to have been narrow-necked points. These results appear to indicate a distinct change in raw material utilization within the last two millennia. This matter will be discussed further later in this chapter.

Projectile point neck width is a critical measurement apparently related to weapons systems and, consequently, to chronology (Corliss 1972; Dumond and Minor 1983:18; Pettigrew 1979, 1981a, 1981b, 1982, 1984, 1985a; Pettigrew and Lebow 1987:8.4-8.5). In the northern Great Basin the bimodal division between narrow-necked (presumably for arrow points) and broad-necked (presumably for

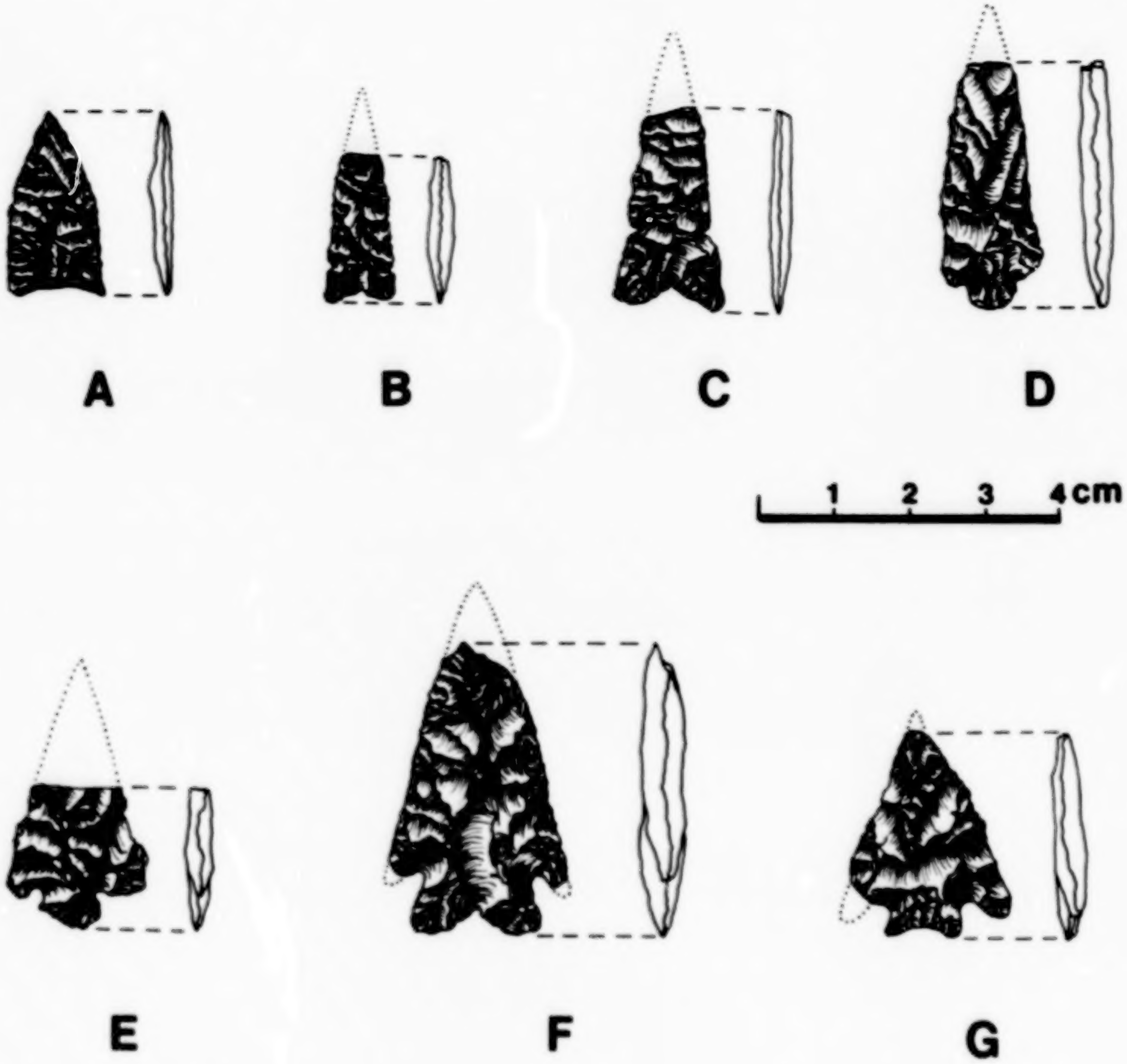

Figure 5.10. Projectile Point Types UST Through EE. Actual Size. Illustrations by Thad Van Bueren.

Type UST (Unstemmed Triangular)
    A: 35ML5316-4
Type SSN (Small Side-notched)
    B: 39-39-5-SW-1
    C: 38-40-19-NW-2
Type RG (Rosegate)
    D: 40-38-1-NE-1
    E: 35ML5329-1
Type EE (Elko Eared)
    F: 35ML5348-1
    G: 37-37-14-SE-3

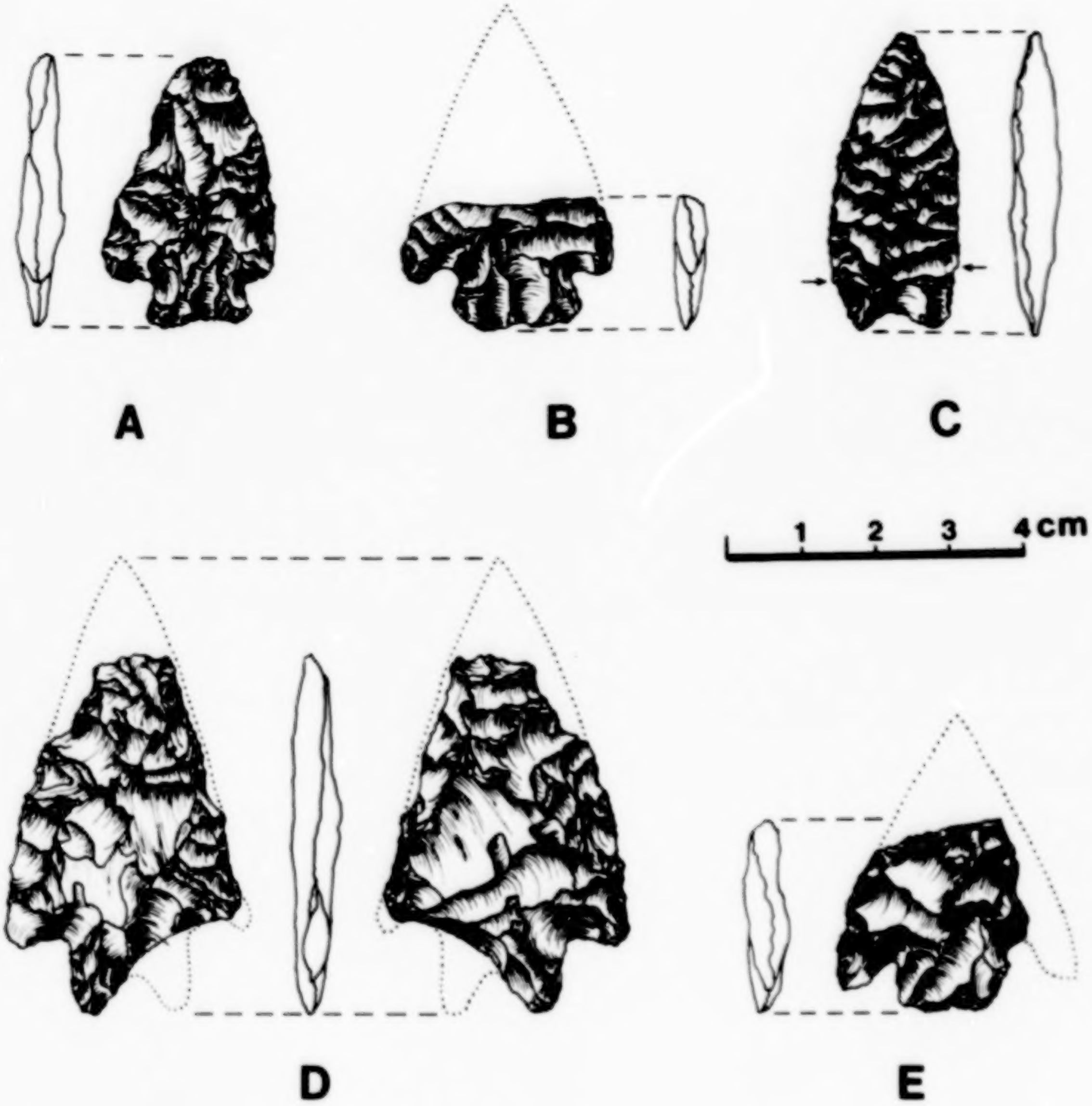

Figure 5.11. Projectile Point Types ECN Through GCS. Actual Size. Illustrations by Thad Van Bueren.

Type ECN (Elko Corner-notched)
  A: 35ML5316-4
  B: 35ML5350-1
Type GSS (Gatecliff Split Stem)
  C: 35ML5300-1
  D: 35ML5360-1
Type GCS (Gatecliff Contracting Stem)
  E: 35ML5316-1

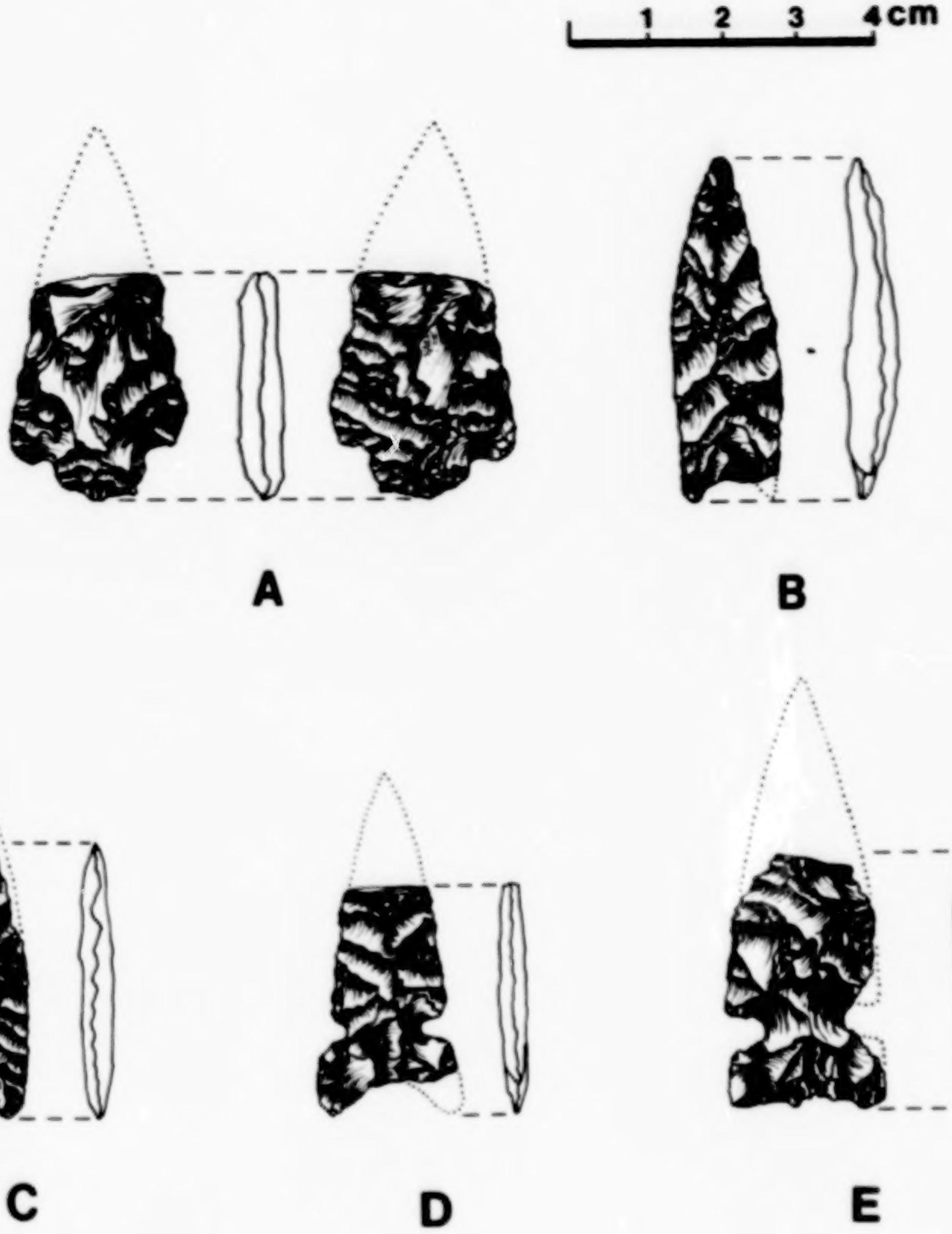

Figure 5.12. Projectile Point Types GCS Through LSN. Actual Size. Illustrations by Thad Van Bueren.

Type GCS (Gatecliff Contracting Stem)
    A: 39-39-5-NW-2
Type HCB (Humboldt Concave Base)
    B: 35ML5350-2
    C: 35ML5329-2
Type LSN (Large Side-notched)
    D: 35HA5105-1
    E: 41-39-5-SE-1

Table 5.10. Projectile Points by Type and Raw Material.

	Whitehorse Obsidian		Other Obsidian		CCS		Total	
Type	Ct	%	Ct	%	Ct	%	Ct	%
SSN	-	--	1	50.0	1	50.0	2	100.0
UST	-	--	-	--	1	100.0	1	100.0
RG	2	28.6	3	42.9	2	28.6	7	100.0
ECN	3	60.0	2	40.0	-	--	5	100.0
EE	3	75.0	1	25.0	-	--	4	100.0
E	3	100.0	-	--	-	--	3	100.0
E/G	3	60.0	2	40.0	-	--	5	100.0
GSS	9	81.8	2	18.2	-	--	11	100.0
GCS	4	100.0	-	--	-	--	4	100.0
HCB	7	77.8	2	22.2	-	--	9	100.0
LSN	2	66.7	1	33.3	-	--	3	100.0
UNC	10	66.7	5	33.3	-	--	15	100.0
Total	46	66.7	19	27.5	4	5.8	69	100.0

arming atlatl darts, spears and knives) points has been shown to occur just above 8 mm (Corliss 1972; Pettigrew 1984, 1985a). A plot of this dimension for the TCOCU specimens, presented as Figure 5.13, exhibits the familiar pattern, with a clear gap at 9 mm. A minor peak occurs at 19 mm, however, which may have additional significance, particularly with reference to the type GSS points, separately indicated in Figure 5.13. Curiously, all points with necks more than 16 mm in width belong to type GSS, which appears to contain, despite the admittedly small sample size, at least two clusters (11-12 mm and 19-21 mm). No non-Gatecliff points have necks greater than 15 mm in width, suggesting that the neck widths reflect a real division into three technological groups (6-8 mm, 10-15 mm, and 16-21 mm). The data are only suggestive, but provoke the interesting thought that the broad-necked points include functionally distinct items, such as atlatl dart points (10-15 mm) and the heads of thrusting spears or knives (16-21 mm). It is possible that these

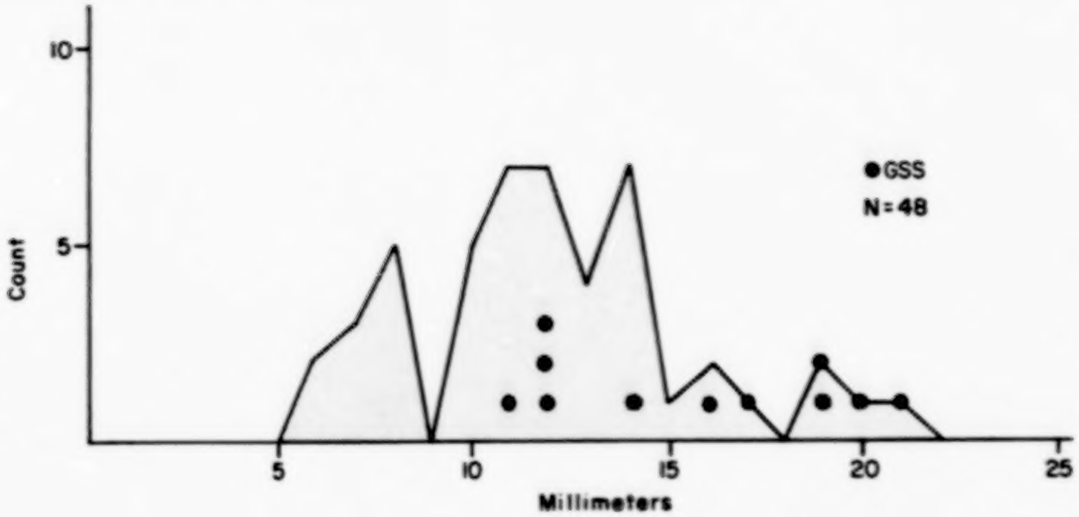

Figure 5.13. Projectile Point Neck Width Frequency.

latter two groups are temporally distinctive as well, with the broader-necked items generally earlier. If so, then type GSS may contain two temporally sensitive sub-types, distinguishable on the basis of neck width. Testing this hypothesis will require more direct investigation of chronology, such as through radiometric dates or obsidian hydration.

The final kind of data to be covered here is that relating to debitage characteristics, which were recorded only on sites and not in off-site contexts. As Table 5.11 shows, the debitage size range was estimated for all but nine prehistoric sites, the percentage of cortex was estimated for the majority of sites, and the approximate raw material proportions were recorded for all sites. These data are only quick estimates made in the field, but nevertheless serve to illustrate an impressive degree of variability in all three categories. Some sites, such as 35ML5322, appear to display evidence of a great deal of primary reduction, with large flakes and large proportions of flakes with cortex. Others, such as 35HA5102, are at the opposite end of the scale, with generally small flakes and little or no cortex represented, and appear to be the result of late-stage reduction, such as sharpening, edge trimming or simply maintenance activities. The majority of sites contain only obsidian, but CCS and basalt are found also, sometimes exclusively. Quadrat 38-38-27-SE appears to contain an inordinate number of sites with some proportion of basalt (four of seven sites), suggesting a basalt source in the vicinity. While only two sites in the northern drainage area are recorded with some proportion of CCS, six sites in the eastern and eight in the southern drainage area fall into this category. Most (seven) of those in the southern drainage area are located in quadrat 40-40-25-SE, where natural CCS cobbles and boulders were found to be abundant, and apparently were used as raw material sources.

Table 5.11. Debitage Data by Quadrat and Site.

Stratum	Quadrat	Site	Size Range (cm)	% Cortex	Raw Material
NO7	39-40-27-NE	35ML5308	1-4	--	OBS
NO6	39-40-5-SE	35ML5333	1-2	15	99% OBS, 1% CCS
	39-39-22-NE	35ML5309	0.5-5	10	OBS
	39-39-13-SW	35ML5310	--	--	99% OBS, 1% CCS
		35ML5311	--	--	OBS
		35ML5312	--	--	99% OBS, 1% CCS
	40-38-1-NE	35HA5100	1-3	20	OBS
		35HA5101	1-2	<5	OBS
		35HA5102	0.2-2	0	OBS
NO5	39-39-9-SW	35ML5358	1-2	0	99% OBS, 1% CCS
		35ML5359	1-2	0	OBS
		35ML5360	0.5-4	<5	98% OBS, 2% CCS
	39-39-5-SW	35ML5338	1-2	3	99% OBS, 1% CCS
		35ML5352	1-2	2	99% OBS, 1% CCS
		35ML5353	1-2	1	99% OBS, 1% CCS
	39-38-24-NE	35HA5111	1-2	2	OBS
NO4	38-38-15-SW	35HA5103	0.2-3	10	80% OBS, 20% CCS
	38-38-27-SE	35HA5104	0.5-5	25	80% OBS, 20% BAS
		35HA5105	0.2-4	<10	99% OBS, 1% CCS
		35HA5106	1-3	10	98% OBS, 1% CCS, 1% BAS
		35HA5107	--	5	99% OBS, 1% BAS
		35HA5108	0.5-4	--	OBS
		35HA5109	1-5	10	95% OBS, 5% BAS
		35HA5110	0.5-4	0	50% OBS, 50% BAS
EA7	40-40-12-NE	35ML5300	1-8	15	99% OBS, 1% CCS
		35ML5301	1-5	15	OBS
		35ML5302	1-5	--	99% OBS, 1% CCS
		35ML5303	1-5	50	OBS
		35ML5304	1-5	--	OBS
		35ML5313	1-5	--	OBS
		35ML5314	--	--	OBS
EA6	38-40-19-NW	35ML5344	1-8	--	OBS
		35ML5345	2-3	--	90% OBS, 10% CCS
		35ML5346	0.5-4	--	OBS
		35ML5347	0.5-4	--	99% OBS, 1% CCS
		35ML5348	0.5-2	--	OBS
		35ML5349	0.5-5	15	OBS
	38-40-20-SW	35ML5335	2-4	10	OBS
		35ML5336	2-4	10	OBS
		35ML5337	2-5	40	OBS

Table 5.11. (Continued)

Stratum	Quadrat	Site	Size Range (cm)	% Cortex	Raw Material
EA5	38-40-1-NW	35ML5334	1-3	<5	90% OBS, 10% CCS
	39-41-21-NE	35ML5350	0.5-2	--	98% OBS, 1% CCS, 1% BAS
	37-37-13-SW	35ML5355	0.5-2	0	90% OBS, 10% CCS
		35ML5356	0.5-5	25	98% OBS, 2% CCS
		35ML5357	0.2-3	0	75% OBS, 25% CCS
	37-37-14-SE	35ML5354	<1	0	OBS/CCS
		35ML5361	2-3	75	99% OBS, 1% CCS
SO7	40-41-7-NE	35ML5305	0.5-2	--	OBS
		35ML5306	1-10	--	99% OBS, 1% CCS
		35ML5307	2-3	--	OBS
SO5	40-40-21-NW	35ML5319	2-8	--	BAS
	40-40-25-SE	35ML5318	0.5-3	--	OBS
		35ML5320	1-4	--	90% OBS, 10% CCS
		35ML5321	2-7	40	OBS
		35ML5322	0.5-10	50	OBS
		35ML5323	1-4	--	90% OBS, 10% CCS
		35ML5326	1-4	--	90% OBS, 10% CCS
		35ML5327	2-5	60	99% CCS, 1% OBS
		35ML5328	2-5	60	CCS (green)
		35ML5329	0.5-3	--	90% OBS, 10% CCS
		35ML5362	--	--	OBS
		35ML5363	--	--	OBS
		35ML5364	--	--	OBS
		35ML5365	--	--	CCS
SO4	41-41-20-NW	35ML5316	1-3	--	99% OBS, 1% CCS

As mentioned above, Whitehorse obsidian (opaque, brown or black volcanic glass) was found to be widely distributed in natural deposits throughout the project area. The material does not appear to be restricted to one or even several primary localities, although some places where it is found are obviously more useful than others for lithic quarrying. Wherever it is found, it is in the form of weathered nodules of varying size, from very small pebbles to large cobbles. The obsidian flows from which the nodules are derived, doubtless associated with the rhyolitic formations north of McDermitt Caldera, appear to have long since weathered away, and the nodules have been transported downslope through mass-wasting processes. Obsidian cobbles and pebbles most often are found on deflated surfaces and where they have been concentrated by alluvial or colluvial deposition.

Most of the obsidian flakes observed in the project area are composed of Whitehorse obsidian, but at some low elevation sites in the northern area other obsidian types were noted.

ASSOCIATION OF CULTURAL AND ENVIRONMENTAL VARIABLES

The most important assumptions and predictions made by this project were those concerned with the influence of environmental variables on human land-use intensity, and the Pettigrew (1984) model of changing patterns of prehistoric land use. Environmental variables were chosen, and weighted according to their assumed relative importance, with the intention of testing the assumptions made. Changing patterns of land use were to be measured largely by use of projectile points (discussed in the following section) as temporal indicators. The purpose of this section is to assess the land-use predictions on the basis of the new data generated by this project, and to refine those predictions as necessary and possible.

Assessment of our assumptions regarding the environmental factors that influenced prehistoric human land-use intensity began with the creation of a dBASE III PLUS file including only the surveyed quadrats and combining the previously recorded environmental data with key measures of land-use intensity: count of sites, site area, and count of prehistoric items. This file was then translated to an SPSSPC system file to allow computerized analysis. The primary object of this analysis was to determine (1) to what extent the original land-use intensity formula actually predicted the recorded measures of land-use intensity, and (2) to what extent that formula, on the basis of the collected data, could be revised to mirror our results. It was thought possible that the new formula could be tested against data generated by previous surveys within the project area. In the end, it was hoped that the new predictive formula would assist in management of the still largely unrecorded body of cultural resources in the project area, and further the scientific goal of understanding the general patterns as well as the details of prehistoric land use in the region.

As discussed earlier, the chosen measures of prehistoric land use are thought to vary in their reliability. The number of sites in a given area can have different significance depending on their surface area (a site can be limited to a diameter of 2 m or can occupy several square km), type (a site with house features surely represents much more activity than a simple rock cairn), density (given the same size, the concentration of cultural debris can vary by several orders of magnitude), and definitional criteria for both sites themselves (some investigators offer strict criteria while others present none at all) and for their boundaries (which often are drawn impressionistically rather than on the basis of explicit parameters). Furthermore, a summary of cultural evidence using only sites inevitably ignores off-site cultural debris, which, particularly in the Great Basin, constitutes a substantial portion of the evidence that exists for cultural activity (Dunnell and Dancey 1983; Lyman 1985a). Consequently, while the site is a useful concept for inventorying cultural resources and for studies of spatially clustered debris and features, it is not likely by itself to provide fully satisfactory data for accurate assessment of land-use patterns in areas like the TCOCU.

The second measure, site area, is related to the first, and suffers many of the same weaknesses, though it does take into account the variability in site size mentioned above. Other factors being equal, a larger site probably represents a greater sum of human activity than a smaller site. Other factors, such as internal site density, site type, and site definition (when comparing sites from different projects) very seldom are equal, however, and off-site data still are not taken into account. Thus, site area seems a better measure of human land use than simply the count of sites, but falls far short of the ideal.

The third measure, the count of prehistoric items, overcomes the difficulties posed above to a remarkable degree, for the actual amount of cultural debris generated by human activity (in the absence of other cultural products such as substantial features or other types of cultural record) constitutes the clearest physical expression of that activity. Through recording and manipulating the actual counts of items, it no longer is necessary to consider sites. In this way we may obviate the problems of site size, density and definition, and thus the count of items may be the best measure available to us. It must be said, however, that some difficulties remain. Other cultural phenomena, such as features and rock art, represent cultural activity not measurable by counts of items. With regard to countable items, many surely have been buried, covered by vegetation, or washed away, leaving us with an imperfect reflection of the original depositional pattern. Further, we still face the perhaps intractable problem of cultural activity that has left no visible trace on the landscape.

To the advantage of using counts of items as a measure of past human activity should be added another: better precision in defining the site, which still has advantages as a classificatory and analytical device. If we can obtain a reliable map of the distribution of items across the landscape, then we can define sites and site boundaries objectively and in the most advantageous way, and in the rich context of the complete array of cultural evidence. What we mean by "site," and its significance in the archaeological record, can thus be understood fully and realistically.

Our conviction that the counts of items per survey quadrat is the best measure of prehistoric cultural activity led to the decision to focus analytical attention on the relationship between environmental factors as the independent variables and counts of items as the dependent variable. The success of the effort to improve the predictive formula, then, was measured first in terms of the correlation between the predicted land-use intensity and the counts of items for each surveyed quadrat

The initial formula used prior to the field survey to estimate land-use intensity was as follows (see discussion in Chapter 4):

$$I = (160/B)\,[a(LPS) + b(LIS) + c(SP) + d(LRD) + e(LRM)]\,[f(L) + g(M) + h(H)] + 0.1,$$

where the parameters a, b, c, etc., were assigned the following values:

$a = 1$
$b = 0.5$
$c = 1$
$d = 0.7$
$e = 0.5$
$f = 1$
$g = 0.3$
$h = 0.1$.

Though this formula was used to categorize quadrats in terms of their likelihood of producing cultural evidence, it was realized from the beginning that our understanding of the actual distributions was meager, and that modification of the formula, perhaps substantially, would be needed.

The straight-line correlation between I (predicted intensity) and PI (prehistoric items) was found to be rather low ($r=.1316$), but improved considerably (to $r=.4402$; $r^2=.1938$; sign.$=.0072$) after adjusting for fractional quadrat areas surveyed and using a logarithmic curve (dependant variable L10PI) (Figure 5.14). Such a correlation was encouraging, since the relationship between the predicted and the actual values was significant, but we had hoped that the correlation would be higher, and believed that modifications in the parameters would improve it. The first attempt to modify the parameters was guided by computed correlations between our dependant variable and the individual environmental factors, but the parameters chosen actually reduced the resultant correlation. Running individual environmental correlations did, however, show that the influence of springs was quite small, and that there was no advantage to using the square root of springs rather than the number of springs itself. Somewhat surprisingly, the single most important environmental variable was LRD, the length of ridgeline.

Improving the correlation between the predicted intensity and the item count required changing the form of the equation itself. A number of different forms were tried, two of which will be presented here. The first involved shifting the slope variables from a separate factor to the simple summed series with the other environmental variables:

$$I_2 = a(LPS) + b(LIS) + c(SP) + d(LRD) + e(LRM) + f(LS) + g(MS) + g(HS).$$

By this means the correlation was brought up above $r=.5$. Adjusting the parameters raised the correlation to $r=.5780$.

At this point examination of the I_2 values in comparison with all the recorded data on the quadrats suggested that elevation, previously ignored, might play an important role in the distribution of cultural debris. It was noted that LRD seemed to have a greater effect on the item counts at higher than at lower elevations, and so elevation was added as a modifier of the LRD parameter:

$$I_7 = a(LPS) + b(LIS) + c(SP) + d((ELEV/K)^T)(LRD) + e(LRM) + f(LS) + g(MS) + h(HS),$$

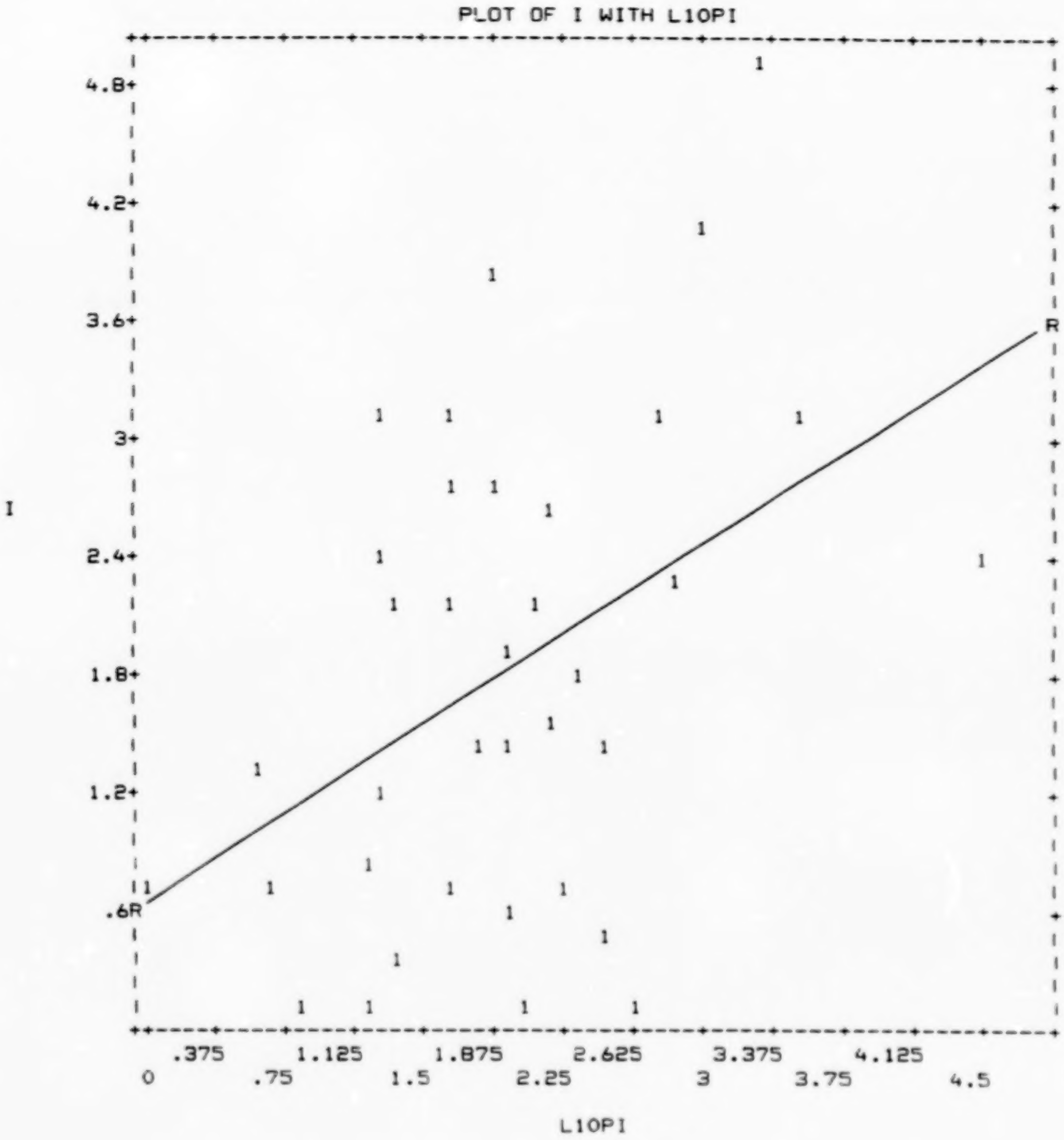

Figure 5.14. Regression Plot for Initially Predicted Land-use Intensity and Count of Prehistoric Items.

where ELEV = elevational interval (4, 5, 6, or 7),

K = a constant between 4 and 7, and

T = a positive constant.

Use of this formula and adjustment of parameters and other constants enabled a dramatic improvement in the correlation to $r=.7284$ ($r^2=.5306$, sign.<.0001). The relationship between I_7 and $\log_{10}PI$, as shown in Figure 5.15, makes use of the following values for constants:

a = 2.2
b = 1.8
c = 0.2
d = 4.4
e = 0.2
f = 0.8
g = -0.1
h = 0.7
K = 6.0
T = 4.0.

Parameters a through h suggest the relative importance of each environmental factor on the distribution of cultural debris. Clearly, LRD, or length of ridgeline (parameter d) carries the greatest weight at elevations above 6000 feet. Between 5000 and 6000 feet LRD carries less than weight than LPS, or length of permanent stream (parameter a), and below 5000 feet LRD falls below LIS, or length of main stem intermittent stream (parameter b), as well, in its relative importance. Both low slope and high slope areas have a notable positive influence on debris densities, the latter possible because of association with ridges. Springs (parameter c) and rimrock (parameter e) are only slightly influential, in the first case possibly because water is never far away in the TCOCU, and in the latter case possibly because rimrock is common throughout the area. Medium slope (parameter g) has a very slightly negative influence, possibly because it is associated with neither water nor ridges, and is too steep to accommodate most uses.

As shown in Figure 5.15, the relationship between the revised intensity predictor (I_7) and the count of prehistoric items (PI) is strong and clear, despite a wide variety of factors at work to thwart our efforts. Counts of cultural debris can be strongly affected by obscuring vegetation, erosion of surfaces, and by deposition that buries objects. Human error can reduce the accuracy of counts, especially in cases where density is high and estimates must be used. Sampling error can reduce the representativeness of the sample counts at the level of the location of transects, and can obscure general patterns at the level of the randomized quadrat selection. The environment adjacent to a quadrat (and not taken into account here) may have an important bearing on land use within that quadrat. Further, other environmental factors of possible importance have not been considered, including accessibility from the lowlands, solar exposure, vegetation types, animal habits, and raw material sources. The latter seems particularly problematic, since our results show, as could be supposed, that evidence of human activity tends to cluster at or near lithic raw material sources, the location of which may defy accurate prediction and usually cannot be known prior to a field survey. Thus, considering the multitude of potential stumbling blocks, a correlation of $r=.7284$ seems remarkably high, and bodes well for future studies of land-use patterns.

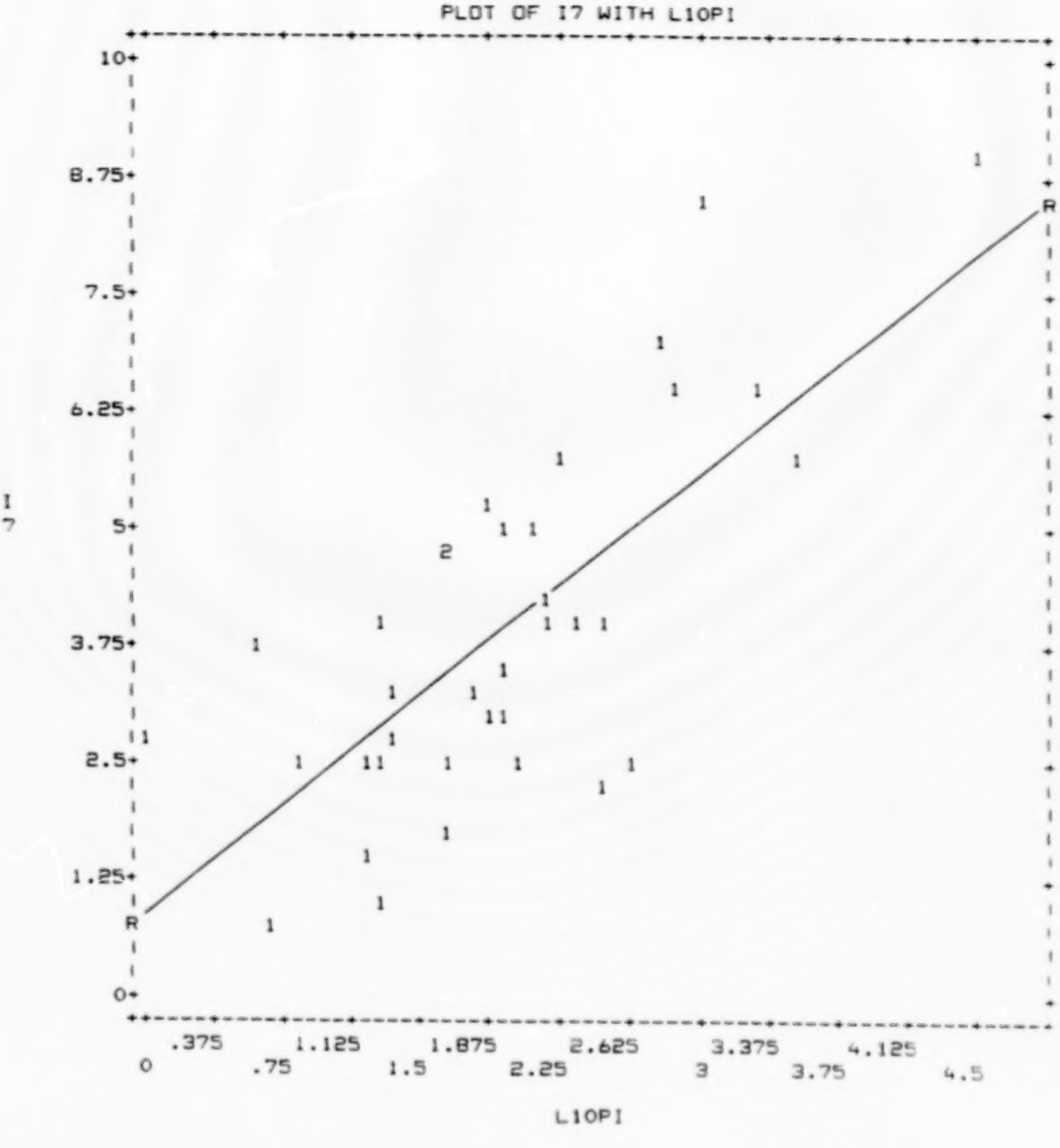

Figure 5.15. Regression Plot for Revised Land-use Intensity and Count of Prehistoric Items.

It is useful also to consider how well the other measures of land-use intensity, site count and site area, fare when compared to the predictions of the revised land-use intensity formula. The pairwise correlation between I_7 and the count of sites (S) for the surveyed quadrats is computed at r=.6150

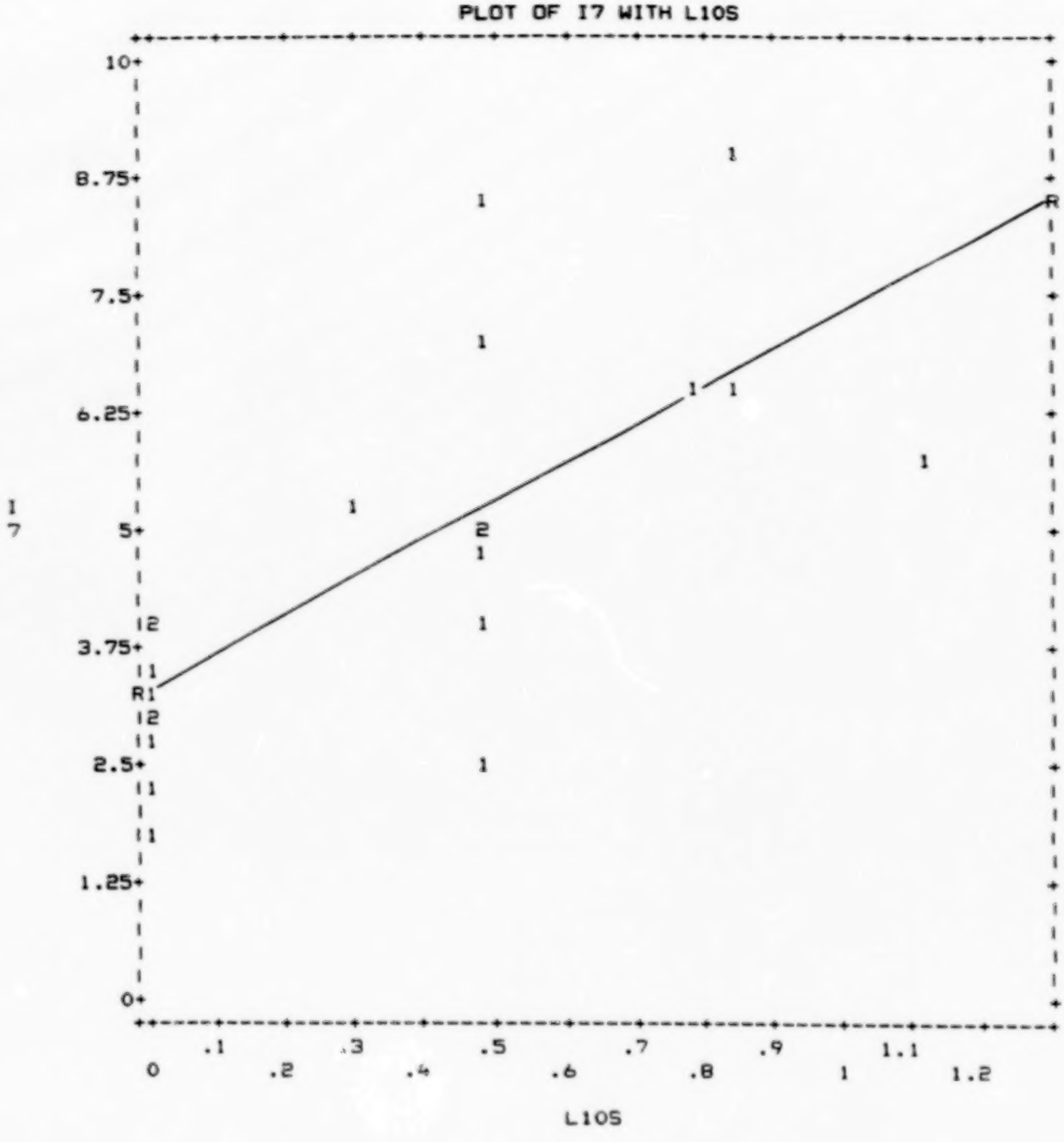

Figure 5.16. Regression Plot for Revised Land-use Intensity and Count of Sites.

(r^2=.3783; sign.=.0001) (Figure 5.16), a reasonably high number, though notably lower than that involving the item count. The correlation between I_7 and site area (SA) was found to be r=.6257 (r^2=.3915; sign.<.0001) (Figure 5.17), slightly higher than for the count of sites, but still notably lower than for the item count. In both cases, the plotted distribution (figures 5.16 and 5.17) is less than satisfying because of the clustering along the

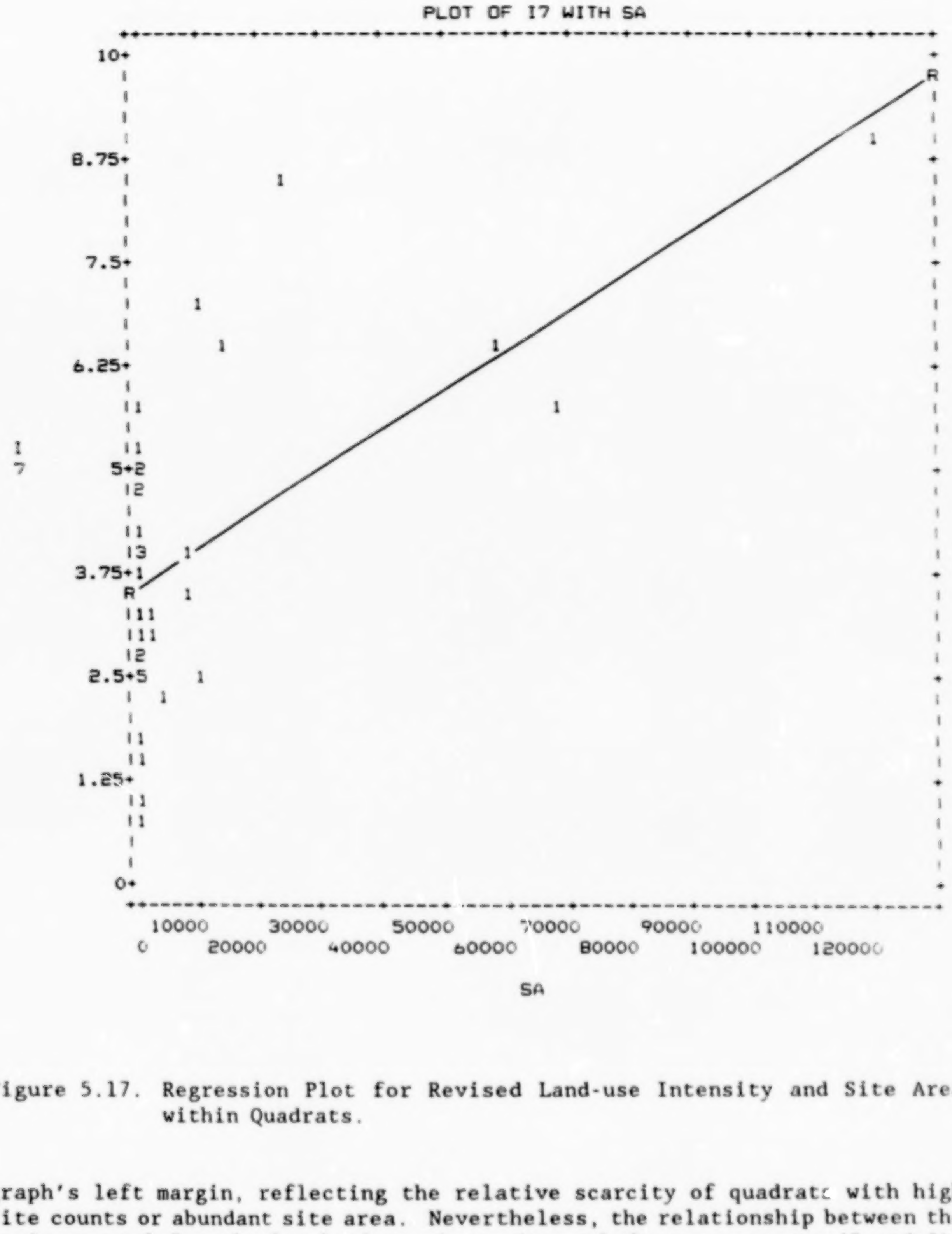

Figure 5.17. Regression Plot for Revised Land-use Intensity and Site Area within Quadrats.

graph's left margin, reflecting the relative scarcity of quadrats with high site counts or abundant site area. Nevertheless, the relationship between the environmental formula for land-use intensity and the two measures (S and SA) of land-use intensity are strong, though not as strong as the relationship using debris counts. The lesser correlations for S and SA may result from the fact that the formula parameters were set to maximize the relationship with PI, but they fit also with the notion that S and SA are less reliable measures of land-use intensity.

We should emphasize here that the predictive value of I_7, even though a high correlation exists with the collected data, has yet to be tested. The formula was adjusted through the use of data collected by this survey; therefore, the formula cannot be tested against the same data. To the extent that the survey sample represents the project area, the formula should have applicability. As stated above, we are encouraged by the highly positive correlation, but the evidence thus far cannot be said to be conclusive, and should not be considered such until confirmatory testing is carried out.

An attempt was made in a small way to test our revised formula against another data set. The data considered were those from the two previous surveys (Hattori 1980; Minor 1980) that covered some areal extent in the project area. Both projects were in the southern portion of our project area, and the quadrats covered completely by these projects (two by Hattori and 18 by Minor) are all between 5000 and 6000 feet; there is, therefore, little environmental variability in the data set. An additional difficulty is that Hattori (1980) provides no site definition, and appears from the site descriptions to be liberal in assigning site designations. Minor (1980:22) defines a site to contain at minimum ". . . 10 flakes per 10 square meters," though we believe that he meant 10 flakes per 10 x 10 m (100 square meters) area.

Applying the I_7 formula to the data set of 20 quadrats, and computing the pairwise correlation between I_7 and S (count of sites per quadrat), we obtain a very low correlation of $r=.0155$ ($r^2=.0002$; sign.=.9483), or very close to no correlation at all. This result appears to stem from the difficulties with the data outlined above, as well as another fact perhaps even more telling. All but one of the sites found by Minor (1980), whose project provides 18 of the 20 quadrats in the data set, are dominated by cryptocrystalline silica (CCS) debitage, and 12 of the sites found by that project were identified as CCS quarries. Of the 13 sites in the two quadrats contributed to the data set by Hattori (1980), two contained natural obsidian nodules, and one of these was a very dense and extensive deposit of that material. Thus, unfortunately for us, the data in the only comparative data set available appear to be skewed by the presence of important concentrations of raw material that cannot be predicted by our formula. Generally, the quadrats surveyed by Minor (1980) and by Hattori (1980) contain many more sites than predicted, clearly because of the attraction of exposed raw material and, in the case of Hattori (1980), possibly because of liberal site designations.

This test of the predictive value of I_7 has value only in pointing out some of the pitfalls of predicting distributions of cultural debris. The samples surveyed by the two previous projects clearly are far from representative of the TCOCU, and thus do not adequately test our formula. A fair test can come only through surveys conducted in the future.

HUMAN LAND-USE PATTERNS IN THE TROUT CREEK-OREGON CANYON UPLANDS

Assessment of land-use patterns, as discussed earlier, requires the consideration of models of adaptive strategy as well as some attempt at temporal control. This section is intended to compare the new data generated by this project with previously collected data sets and alternative land-use models in the neighborhood. The object here is to develop an improved model of regional land use that accounts for the new as well as the previously reported data. The discussion begins with chronology, particularly as it relates to changing patterns of land use, then moves on to the particulars of land-use patterns.

CHRONOLOGY

Reliance upon surface evidence in this project necessitates the use of projectile points as temporal indicators. A potential alternative would be the measurement of obsidian hydration rims, which is outside the scope of this project, and for which a systematic study of obsidian sources and hydration rates would be needed.

The use of cross-dating by projectile points poses important difficulties that are widely understood by North American archaeologists, though sometimes ignored by project researchers. Two major problem categories exist, those relating to classification of temporal types, and those involving temporal assignments. As we shall see, both problems continue to plague prehistoric research in the Oregon-Idaho-Nevada border region.

Projectile point classification is a key issue because types commonly are the standards by which point populations are compared. Point assemblages classified using variant defining criteria cannot be compared confidently, since the relative proportions by type for one collection may differ from those of another collection purely because of the classification schemes used. Differences between collections can be interpreted usefully only by employing the same classificatory yardstick. In the Great Basin this problem in former years was pronounced, especially since different researchers often used the same type names but defined them differently, thus masking the inherent differences between the classifications. Substantial improvement in this situation resulted from the effort by Thomas (1981), following the study of a huge population of points from many different sites and areas, to develop a Great Basin-wide typology using strict type definitions based on a series of measurements. Thomas' types were designed to maximize temporal sensitivity, and thus are ideal for cross-dating.

Unfortunately for those of us carrying on research in the Oregon-Idaho-Nevada border region, some of the most important contributors have chosen to ignore or eschew the Thomas scheme in favor of their own systems. Projectile points from the Steens Mountain Project survey (Beck 1984; Jones 1984), with a very large population numbering 1,267, were classified by use of a three-dimensional system that incorporates some attributes used by others, but which does not directly conform to previous typologies. Despite the lack of direct comparability with named types (especially with well defined named types), Beck (1984:92) loosely associates her types with named Great Basin types, and eventually uses the named types so defined as the chronological basis (developed through cross-dating) for the interpreted changes in land-use patterns.

The excavated points from the Steens Mountain Project (Wilde 1985) offer perhaps even greater obstacles to inter-project comparison. The 600 classifiable points analyzed (565 of which are from Catlow Cave and Roaring Springs Cave, excavated decades earlier) were typed using familiar Great Basin terms, but no defining criteria are given beyond references to multiple bibliographic sources for each type used. Despite a sophisticated discriminant analysis employed to develop consistent type assignments, no means is provided for a comparison of the Steens Mountain Project excavated points with points from other projects, except for the relative proportions of types, which may or may not be the same as those types used by others. Compounding the difficulty is the complete lack of artifact illustrations, and the absence of projectile point data of any other kind.

In the region of southwest Idaho, Plew (1985, 1986), by far the principal contributor for that area, simply ignores the Thomas classification scheme while using familiar Great Basin terminology, though he does present type descriptions and gives references for comparable types described by others. His descriptions and illustrations in some important cases, especially in regard to the Elko series, leave doubt as to the reliability of type assignments in his large collection of 430 points. Particularly troubling is the reported lack of Gatecliff series (otherwise called Pinto) points in the study area, in the face of two clearly Gatecliff points illustrated in the Nahas Cave report (Plew 1986:58-60) but grouped with the Elko series.

Within the TCOCU, the two researchers (Hattori 1980 and Minor 1980) reporting on projectile point collections recovered during earlier surveys completed their reports before the publication of Thomas (1981), and their point type assignments are made without the benefit of a strictly systematized classification. Comparisons with their data, therefore, must be made carefully and with this limitation in mind. Fortunately, both provide useful artifact illustrations which in a number of cases allow corrections of type assignments made by the authors.

Other key researchers in the region have, however, made use of the Thomas typology. Hanes (1988) for Dirty Shame Rockshelter (226 classifiable points) and Pettigrew (1984) in the Alvord Basin (326 classifiable points) both adopted the Thomas scheme as the basis for point classification, thus minimizing doubts about the comparability of their results.

Another problem of classification is technological, relating to the potential for formal modification during the useful life of a specimen. Flenniken and Raymond (1986) show that the sharpening, repair, and rejuvenation of a point may result in morphological changes resulting in a shift from one typological class to another. Analysis of point collections, then, should take this factor into account, and consider the typological variability possibly caused by lithic reduction behavior and point fragmentation. At least it should be understood that we should not expect high levels of morphological homogeneity in point collections, even when only small temporal increments are represented.

Once a group of points is classified into what are believed to be temporally sensitive types, another set of problems must be faced in the process of interpreting the time periods represented. In the present case, we need to interpret the changing intensity of land use in the TCOCU project area in terms of a chronological framework, despite varying opinions about the periods when particular point types were in vogue. To accomplish this, one must consider a wide range of evidence connecting point types to time periods.

Published stratigraphic sequences from excavated sites with radiocarbon dates are the preferred basis for establishment of projectile point chronologies. Such sequences can provide good information about the relative sequence of temporally sensitive artifacts as well as objective dates associable with particular periods. This kind of evidence, however, can be and often is misused. In the Great Basin, most published stratified sites are caves or rockshelters, containing rather small volumes of cultural deposit and often used very intensively in prehistoric times. Such sites frequently show evidence of substantial man-caused disturbance prehistorically as well as historically. Stratigraphy is often very complex and difficult to follow, and natural bioturbation should be assumed even when no clear evidence for it is found.

Not even considering the factors possibly skewing radiocarbon dates, artifacts found in excavation can be misidentified temporally because of prehistoric collection and retrieval of already ancient tools (by this process older objects can appear in younger deposits), disturbance of deposits by occupational activities (pit-digging, building of shelters, etc., which can move objects up or down in the profile), bioturbation (which also may move objects up as well as down), misinterpretation of stratigraphy during excavation (thus mixing together strata laid down separately), and lumping of strata for analytical convenience following excavation. The less the total volume of cultural deposit for a given length of occupational time represented, and the greater the occupational intensity, the greater will be the problems of mixing together objects deposited on the site at different times. It seems clear, then, that caves and rockshelters are particularly prone to this form of confusion, much more so than sites buried in thick alluvial strata alongside large rivers, few of which have been reported in the Great Basin. As a general rule, it should be assumed that projectile points in excavated cave and rockshelter sites are mixed to some degree between levels and between strata. The mere presence of a point type in a given stratum does not indicate automatically that that type is dated by the radiocarbon dates assigned to that stratum. Temporal interpretations should be made provisionally and on the basis of the entire corpus of data available, including multiple stratified sites if possible to increase confidence in the interpretations made.

Beck (1984:131-153) provides a good example of the serious errors that can result from uncritical acceptance of data from excavated sites. She selects a series of 13 excavated sites in the northern Great Basin, plots the relative frequencies of point types by radiocarbon-dated levels, and interprets the "earliest appearance" of a given point type to be the earliest date for the lowest stratum in which that point type appears in the published sequence, or, even worse, an estimated age based on the depth below the nearest applicable radiocarbon date. This procedure can only result in erroneously early temporal assignments for point types, because it ignores the practical problems listed above. As a consequence, Beck asserts that Rosegate points arrived in the Steens Mountain area at 3000 B.P., and Desert Side-notched at 1500 B.P., both dates significantly earlier than most knowledgeable archaeologists find acceptable. A more reasonable, though perhaps more difficult, approach would have been to look carefully at the temporal and stratigraphic patterns observable in the published sites compared, and consider the possible range of dates allowable at each site for each of the types under consideration, given the inevitably fuzzy nature of the data.

Besides stratified sites, other forms of temporal evidence exist and should be used. Two that come readily to mind are obsidian hydration and seriation of spatially separable point populations. Obsidian hydration (Hughes 1984, 1986) can be either a purely relative or an objective dating method, depending on the development of an obsidian hydration rate for specific sources at a specific locale. Despite the complicating factors, obsidian hydration can provide key evidence regarding projectile point chronology (Hughes 1984, 1986; Layton 1972, 1985; Tuohy 1980), even for surface-collected artifacts (McGonagle 1979). Still, in the absence of an established rate, the determination of relative placement might help resolve such difficult problems as the potential existence of both early and late Elko series points and the definitional criteria of morphologically similar but potentially temporally distinct point forms (see Hanes 1988:21).

The seriation of spatially separable point populations is a well established method in archaeology (Ford 1962), and one that can be applied to collections from excavated or surface contexts. Close to the TCOCU, Beck (1984) seriates site assemblages found during the Steens Mountain Project survey in the process of creating her temporal periods. What may not be realized by some archaeologists who consider buried sites to be the only valuable source of field data is that surface sites (particularly single-component sites), through such methods as seriation, can offer a means by which to fine-tune our chronological assessments. As one of us (Pettigrew 1983) has pointed out, surface assemblages not only have more easily extractable data than buried sites, but they often represent distinct time periods not subjected to the post-depositional blurring endemic to buried sites. Thus, while it may not be easy to find "pure" Elko or Gatecliff components in a buried context, such may indeed be possible with surface sites occupied for short periods and then abandoned, leaving a precious reflection of an instant in time not observable in any other way. Through seriation, such sites can be placed into the regional chronological framework, and dated as precisely as any buried stratum.

Another form of seriation, one that does not depend on the Fordian "battleship curves," is co-occurrence analysis (Pettigrew 1983, 1984), by which the tendencies for point types to be found together, or co-occur, can be measured and portrayed in such a way as to reproduce the temporal sequence in which they occurred. This method was applied by Pettigrew (1984) to the problem of ordering point types recorded by the Alvord Basin survey (Pettigrew 1975), where it was shown that point types were distributed differently over the landscape, in terms of both horizontal and elevational placement. One advantage of this technique over the Fordian seriation method is that one need not have substantial numbers of points for each site (or other compared unit) in the data base. A minimum of only two points is required, since the method essentially tabulates co-occurring pairs of items rather than relative proportions among a population. Thus, co-occurrence analysis can make use of the sometimes sparse data available from surface assemblages in situations where Fordian seriation is essentially useless.

Our analysis of the existing data on projectile point chronology for the Oregon-Idaho-Nevada border region results in the temporal estimates summarized in Figure 5.18. These estimates are influenced by a wide range of evidence, with particular reference to discussions by Hanes (1988), Layton (1985), Pettigrew (1984), and Wilde (1985). The "Early" group includes fluted points, broad-stemmed shouldered varieties often referred to as Great Basin Stemmed, Windust, Lake Mohave, Haskett, or Plano, large foliate points, and crescents, and is estimated to have been in use from earliest occupation nearly 12,000 years ago to about 6000 B.P., though rather little evidence for their use is younger than about 7000 B.P. Wilde (1985:149), in his comparative study of northern Great Basin projectile point chronology, determined a mean date for the Early group between 8900 and 9000 B.P.

The Large Side-notched (LSN) group is considered to range from about 8000 to about 3000 B.P., with greatest frequency between 7000 and 4000 B.P. Wilde's (1985:149) mean date for this type is 6345 B.P.

The Humboldt series is generally believed to have rather little temporal specificity, and appears to range in age from about 9000 to 2000 B.P., with greatest use between about 7500 and 3000 B.P. Wilde's (1985:149) mean date is 4426 B.P.

Gatecliff series (particularly Gatecliff Split Stem) points are often referred to by the more traditional name of "Pinto," widely known throughout the Great Basin but apparently existing in various forms of possibly various ages. Evidence exists suggesting that shouldered, split-stem points are rather early (ca. 8300-6200 B.P.) in the eastern Great Basin (see discussion by Hanes 1988:23-24), but most data from the northern Great Basin place this style within the range 5000-2000 B.P., with occurrences most commonly between 4000 and 2500 B.P. Layton's (1985) obsidian hydration results from the High Rock Country of northwestern Nevada clearly show that Gatecliff overlaps both LSN and Elko in time. Wilde (1985:149) reports a mean date of 3547 B.P. for Gatecliff Split Stem points.

The Elko series is estimated here to range from 5000 to about 1000 B.P., with the most intensive usage in the period from about 3500 to 1500 B.P. Much discussion in the literature has focused on the Elko chronology, which is rather controversial. Wilde (1985:149) suggests that Elko points may have risen to prominence twice, and he gives two mean dates, 2489 B.P. and 6138

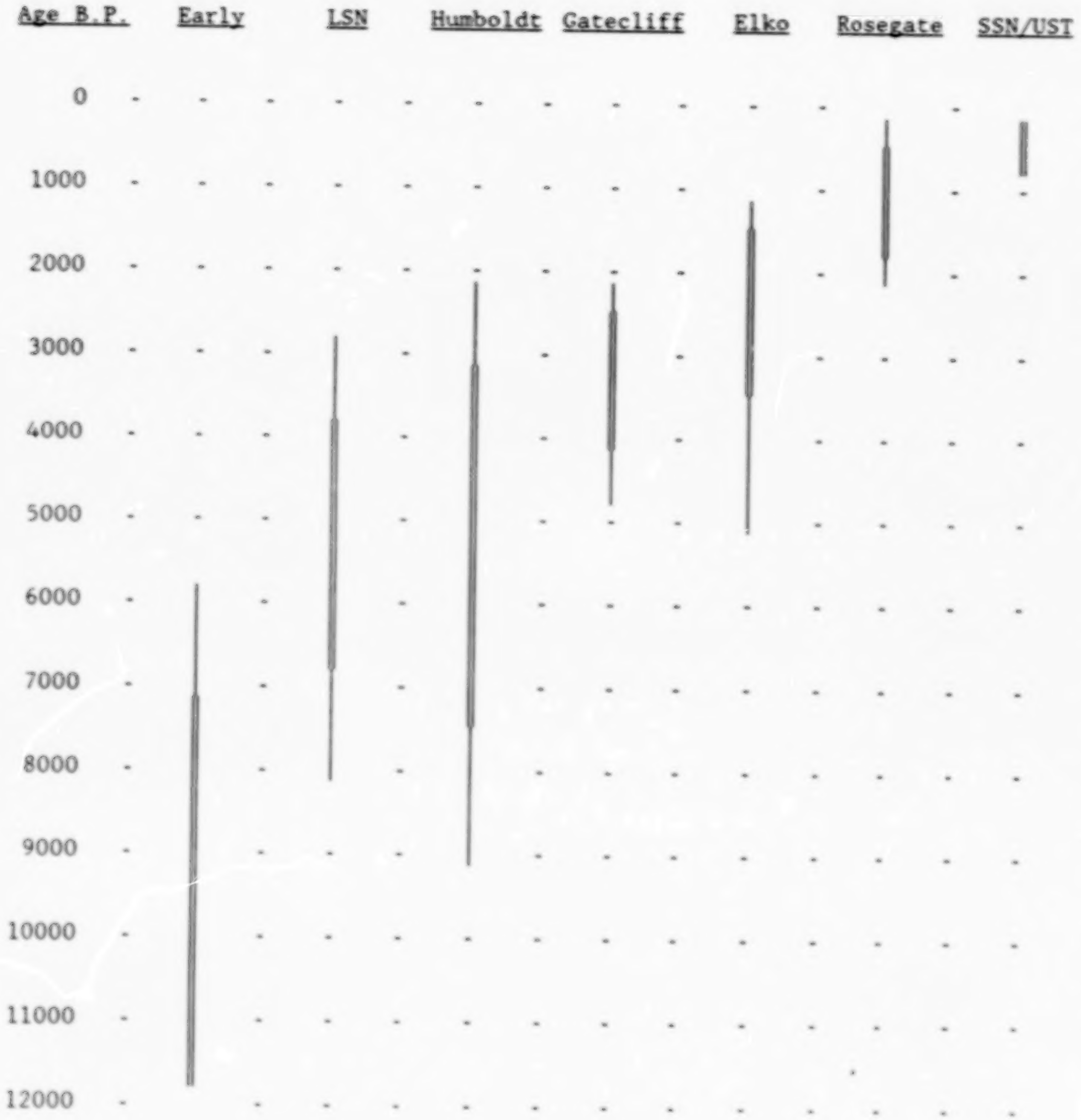

Figure 5.18. Period Estimates for Projectile Point Groups.

B.P., based on his analysis of Great Basin data. His discovery of a concentration of Elko series points beneath Mazama ash (ca. 6700 B.P.) at Skull Creek Dunes is strong evidence for an early Elko horizon at that site, though in the absence of illustrations or any other data on the points the report cannot be said to be conclusive. Hanes (1988:23), by contrast, sees evidence from stratified sites in the eastern and northern Great Basin indicating an introduction of the Elko series prior to 7000 B.P., with greatest use prior to 5500 B.P. The most convincing evidence of early Elko, however, seems to come from sites in the eastern Great Basin and from the Skull Creek Dunes site in Catlow Valley (Wilde 1985) discussed above. The other northern Great Basin sites mentioned by Hanes (1988), Odell Lake and the Connley Caves, do not offer convincing evidence for an early Elko horizon. In the case of Odell Lake (Cressman 1948), near the crest of the Cascade Range at the headwaters of the Deschutes River, the only Elko series point recovered was found by a Forest Service engineer during excavation of a building foundation one year prior to the appearance of archaeologists on the scene. Cressman himself expresses doubts about whether it belongs to the sub-Mazama ash assemblage.

With regard to the Fort Rock Valley data, Bedwell (1973:149) indeed reports that about half of the classifiable points in his Unit 2, estimated to date from 8000 to 7000 B.P., are corner-notched. Making use of Bedwell's data is problematic, however, for several reasons. Bedwell's (1973:137-165) summary of changing material culture involved the grouping of components from eight separate Connley Caves and from Fort Rock Cave into a series of four stratigraphic units. To each unit, interpreted to represent a distinct temporal period, are assigned selected arbitrary levels or strata from the various components, based on a variety of considerations. The book does not report the data from the stratigraphic units or from the components, detailed coverage of which is given in Bedwell's dissertation (Bedwell 1969), but merely summarizes the patterns observed. Given that the defining criteria for the unit divisions are not specified, and that mostly arbitrary levels (rather than stratigraphic sections) were basic elements in the unit groupings, it seems quite possible that the corner-notched (generally Elko series) points actually belong in Unit 1, dated by Bedwell to the period 5000-3000 B.P.

Close reading of the dissertation (Bedwell 1969) reveals that the 1966 and 1967 excavations in Fort Rock Cave found no solid Mazama ash layer, as had been unearthed during Cressman's excavation in 1938. Instead, patches of ash were found below a thick section of pumiceous sandy silt, a likely interpretation of which is that prehistoric disturbance of the deposits had taken place. Despite the moderately complex stratigraphy at the site, Bedwell chose to group mostly arbitrary levels rather than strata into his temporal units. Further, the projectile points themselves suggest mixing between levels. At Fort Rock Cave, one Rosegate point is assigned to Unit 2 (dated 8,000-7,000 B.P.), and three Rosegate specimens to Unit 3 (dated 11,000-8,000 B.P.), while five Elko series points are assigned to Unit 2, two to Unit 3, and one to Unit 4 (dated earlier than 11,000 B.P.). One of the 15 classifiable points assigned to Unit 2 at the Connley Caves is a Rosegate specimen. Thus, the supposedly pre-Mazama cultural deposits reported by Bedwell (1969, 1973) are clearly mixed to some degree with post-Mazama deposits. Reanalysis of the Fort Rock Basin data is needed before acceptance of pre-Mazama Elko points there.

The projectile point sequence from Dirty Shame Rockshelter (Hanes 1988:145) offers support for the presence of early Elko series points in southeastern Oregon, since the majority (15 of 25) were found in cultural strata considered to date prior to 5900 B.P. There is no doubt, however, that the deposits in the site have been mixed to a substantial extent (Aikens et al. 1977:8; Hanes 1988:15), and that the division of the deposits into six zones was done with some difficulty and arbitrariness (Aikens et al. 1977). Obsidian hydration measurements on 32 specimens (30 of which were flakes) (Kittleman 1977:7-8, 17) from all but the uppermost zone revealed essentially no pattern, with measurements in each zone scattered about a mean of about 5.5 microns. Though Kittleman did not separate specimens by source, in the absence of mixing we would expect to see some kind of patterned reduction of readings from bottom to top in the site, and the obsidian data do not inspire confidence in the temporal discreteness of the zonal point populations. Consequently, while vertical patterning in point types clearly is obvious and of comparative value, it may not be safe to rely on these data as the basis for a projectile point chronology. General trends exist, but to address such a sticky problem as the time of introduction of the Elko series we need sites with clearer and better separated cultural strata. Dirty Shame Rockshelter does not offer conclusive evidence for an early appearance of the Elko series, though the evidence is strongly suggestive and awaits confirmation.

Further compounding the difficulty with the Elko chronology is the location of the TCOCU project area, which can be said to lie between the eastern and western parts of the Great Basin, and thus cannot confidently be aligned with either the eastern or the western Elko chronologies. As summarized by Hanes (1988:23), the Elko series is not documented in the western and central Great Basin before 3500 B.P. For example, excavations in Surprise Valley in northwestern Nevada by O'Connell (1975:34) place the Elko series primarily between radiocarbon dates of 2850 and 2150 B.P., and the very well controlled Gatecliff Shelter excavations in central Nevada (Thomas 1983:177) show the Elko series restricted primarily to the period 3300-1250 B.P. If the Elko series was introduced in the eastern Great Basin by 7000 B.P. and was common there prior to 5500 B.P., then it might have been introduced in the southeastern corner of Oregon earlier than in central and northwestern Nevada. Early introduction is not evidenced by Layton's (1985) obsidian hydration data from two sites in the High Rock Country (though three of the 42 measured specimens have thick hydration rinds comparable to the large side-notched points), but a long Elko chronology is suggested by the Dirty Shame Rockshelter evidence. The TCOCU is between the latter two localities, and one cannot say _a priori_ that the first or the second set of evidence is more applicable.

It is possible, as suggested by Hanes (personal communication 1989) that an early Elko horizon does exist west of Dirty Shame Rockshelter, but that the period has not been well sampled. If, as proposed by Pettigrew (1984), population density in the northern Great Basin declined substantially by ca. 7000, but rebounded after 5000 B.P., then early Elko sites may simply be difficult to find because of a severely reduced number of sites used during the period. This explanation can work only if two discrete Elko periods existed, as suggested by Wilde (1985), since much evidence places the Gatecliff series and the Large Side-notched group earlier in the sequence than Elko. A period of diminished occupation does appear in the obsidian hydration data presented by Layton (1985) in the 4.5-5.1 micron range, but this period may not be early enough or long enough to explain the lack of early Elko points.

With regard to the Elko series chronology, then, we are left with an unsatisfactory situation that will require further research to settle.

The Rosegate series is estimated here to have been introduced (along with the bow-and-arrow) at or shortly before 2000 B.P., and to have continued in use essentially to the time of contact. Its principle period of use, however, appears to be about 1800-500 B.P. Wilde's (1985:149) mean date for the Rosegate series is 1115 B.P. The bow clearly was introduced from northeastern Asia, and thus diffused from north to south in North America, where it appeared on the lower Columbia River between 2450 and 50 B.P. (Pettigrew 1981) and on the lower Snake River at about the same time (Brauner 1976:320-321). Arrowpoints were well developed and dominant in central Oregon by 1660 B.P., but were not introduced until well after 2850 B.P. (Pettigrew 1982). Although Webster (1978) believes that narrow-necked points at Dry Creek Rockshelter near Boise may date as early as 2400 B.P. the two (of 35 total) Rosegate points found below level 10 (where a radiocarbon date of 2090 B.P. was obtained) seem likely to be out of place.

At Dirty Shame Rockshelter, Aikens et al. (1977) interpret the record to show that arrowpoints were introduced some time after 2700 B.P. The earliest Rosegate points clearly associable with radiometrically dated material were found above the floor but beneath the preserved structural portions of a pole-and-thatch house that was apparently rebuilt numerous times. House remains dated to 2545, 2005, 1715, 1480, 1175, and 1140 B.P., the first two of which relate to burned structural supports. Given the likelihood of floor sweeping by the occupants and re-use of wooden raw materials, the earliest date may be earlier than the recovered arrowpoints. Thus, the data here are not inconsistent with the interpretation that the Rosegate series was introduced near 2000 B.P.

Evidence from Gatecliff Shelter (Thomas 1983) in central Nevada is widely cited to show that Rosegate points did not appear there until 1250 B.P., which seems rather late to us, given the relatively short distance between that location and southeastern Oregon. That site is also curious because of a near lack of overlap in time between the Elko and the Rosegate series, while most commonly to the north a clear temporal overlap exists. Examination of the radiocarbon date proveniences and the stratigraphic distribution of typable projectile points (Thomas 1983:42, 177) reveals that the 1250 B.P. date is an interpolation between a radiometric date of 1000 B.P. in Horizon 3, where Rosegate points are numerous but Elko series points are almost absent, and Horizons 4 and 5, which together produced eight dates ranging from 3690 to 1580 B.P. associated with a nearly pure Elko component. Horizons 3 and 4 were separated by a sterile stratum that took some time to develop, and so it seems quite possible, even likely, that Rosegate points were introduced into central

Nevada by about 1700 B.P., near the end of occupation of Horizon 4, and no more than 300 years after their appearance in southeastern Oregon. By at least 1250 B.P. they had already become the dominant type, likely following an undocumented period when Rosegate and Elko points were both used.

The Small Side-notched (SSN) and Unstemmed Triangular (UST) types were the last projectile points to be introduced in the TCOCU area, probably at some time following 1000 B.P. Type SSN points may have arrived as late as 500 B.P., and type UST may have come in slightly earlier. Wilde (1985:149) reports a mean date of 633 B.P. for SSN and 734 B.P. for UST.

With the temporal estimates for the projectile point types in mind, review of the new data from the TCOCU in comparison with adjacent project areas should help us interpret the chronology of human use of the TCOCU project area. Table 5.12 lists the projectile points by type from the 1988 TCOCU project alongside those collected from the project area by the more spatially limited surveys of Hattori (1980) and Minor (1980). The points from these earlier surveys were reclassified for this purpose on the basis of the descriptions and illustrations offered by those authors. What stands out in these data is the remarkable similarity that exists, despite potential problems with varying classification and sampling error. The combined population of the Hattori and Minor surveys shows nearly the same proportions for Gatecliff, Elko and Rosegate as the 1986 TCOCU survey sample. The only potentially significant differences are for the Humboldt and Early groups, both only at the .10 level. The TCOCU survey found proportionately more Humboldt, and fewer Early specimens, than the combined Hattori and Minor sample, but these difference may simply reflect the areal specificity of the Hattori and Minor surveys, which focused on the southern ridgeline and hills, as compared to the broad representative coverage of the TCOCU survey. It seems possible that the southern ridgeline and hills were used somewhat more during the early and middle Holocene (ca. 12,000-4,000 B.P.) than was the TCOCU project area as a whole (thus creating larger proportions of LSN and Early points, and fewer Humboldt points), though the data are not conclusive on this matter. Comparing the 1988 TCOCU data to the temporal estimates presented in Figure 5.18, it appears that the most intensive use of the TCOCU took place between about 4000 and 2000 B.P., when Gatecliff points were at their peak and when both Humboldt and Elko points were common as well. Little or no use of the project area is seen for the period prior to 7000 B.P., when Early points were in vogue, and the same may be the case for the period 7000-4000 B.P., though some of the LSN, Humboldt, Gatecliff, and Elko points may have been deposited then. The period following 2000 B.P. seems to have experienced a decline in land-use intensity from the earlier peak, though use is evidenced through the latest prehistoric period.

LAND-USE PATTERNS

Human land-use patterns in the TCOCU can have meaning only in terms of their place in the patterning observable in the regional data. The most important data we have, aside from the TCOCU data collected in 1988, are those from the Alvord Basin survey (Pettigrew 1975, 1984) and from the Steens

Table 5.12. Projectile Points by Type from the 1988 TCOCU Project and Earlier Surveys in the Project Area.

TYPE	TCOCU ct.	TCOCU %	Hattori (1980) ct.	Hattori (1980) %	Minor (1980) ct.	Minor (1980) %	TOTAL ct.	TOTAL %
SSN/UST	3	6.1	1	1.9	0	0.0	1	1.5
RG	7	14.3	7	13.0	3	27.3	10	15.4
ELKO	12	24.5	12	22.2	2	18.2	14	21.5
GATECLIFF	15	30.6	18*	33.3	3	27.3	21	32.3
HUMBOLDT	9	18.4	4	7.4	1	9.1	5	7.7
LSN	3	6.1	9	16.7	1	9.1	10	15.4
EARLY	0	0.0	3	5.6	1	9.1	4	6.2
TOTAL**	49	100.0	54	100.0	11	100.0	65	100.0

* includes only split stem, not the 5 contracting stem points that were also collected.

** excludes indeterminate points.

Mountain project (Beck 1984; Jones 1984; Wilde 1985). Two different models of land use have been proposed for the Alvord-Steens area, one by Pettigrew (1984) and one by Beck (1984). Our choice for a model by which to view the TCOCU project results is the former, because the Pettigrew model appears to account reasonably well for substantial cultural evolution evidenced over the entire range of prehistoric time, while the Beck model sees little cultural change and interprets the changes that are observed in terms of simple adjustments to environmental fluctuations. Perhaps more important are the serious weaknesses in Beck's temporal assignments, which are the foundation upon which are based the interpretations of land-use changes in the Steens Mountain project area. The Steens Mountain chronology was developed through a seriation of 18 sites that yielded nine or more projectile points (Beck 1984:98, 129). These 18 sites were then grouped into temporal periods according to interpretations based on a study of regional chronology (Beck 1984:131ff), some problems with which have already been alluded to. Finally, the remaining 54 sites (some further subdivided into components) with projectile points were assigned to temporal periods on the basis of the types represented, even where only a single point was found. Examination of the list of sites with their point types and assigned periods (Beck 1984:154-157) raises serious doubts about the reliability of the temporal assignments, which seem unsystematic and unrealistic. For example, in most cases a site is assigned to a single period, even when types likely to be from various periods are found. Furthermore, the sample sizes, most of which are less than nine, generate little confidence in the period designations. If these assignments were treated simply as rough guesses, we would have rather little difficulty with them. Unfortunately, they form the basis for the interpretations of changing land-use patterns for the entire Steens Mountain project, since the basic statistic used in that analysis (Beck 1984:223-254) is the number of sites per chronological period. In our view, because the temporal assignments are so highly suspect, this statistic is of rather little use. We choose instead to use counts of projectile points by type to measure occupational intensity by period, and we choose not to use the Beck model of prehistoric land use. Projectile point counts are by no means perfect measures, since they cannot represent all kinds of use and may be subject to technological bias (such as the influence of the atlalt versus the bow-and-arrow) as well as the possible skewing effects of prehistoric scavenging, but they are the best available indicator directly linking land use with chronology.

Our project area, as a very distinctive upland zone, is best seen as an example of the upland-lowland dichotomy by which land use in the region has been researched since the beginning of systematic areal survey. Table 5.13 presents the projectile point data from the TCOCU project alongside the data obtained for the Alvord Basin survey (Pettigrew 1984) and the Steens Mountain survey (Beck 1984; Jones 1984). As discussed above, the TCOCU and Alvord point collections were both classified using the Thomas (1981) system, and thus can be compared with some confidence, while the Steens Mountain data may differ systematically from those of the other projects because of the use of a different classification. The magnitude of this inherent bias, if it exists, remains to be determined. Nevertheless, the differences among the samples are very interesting. The most obvious pattern in Table 5.13 is the huge numbers of Early points found by the Alvord Basin survey (109 of 326 points), compared to the very small numbers recorded by the other collections. The difference between the Alvord Basin survey collection and that from the TCOCU is significant at the .001 level, and at a much lower level when compared to the Steens samples. This result appears to support the proposal by Pettigrew (1984) that upland use during the Western Pluvial Lakes Tradition (11,000-7,000 B.P.) was very limited by comparison to later periods. One might ask, however, how it can be that the Steens project lowlands sample, which covers some of the area encompassed by the Alvord Basin survey, is so relatively impoverished in the Early category. The Steens lowlands sample does have a significantly higher proportion of Early points than the Steens uplands sample (at .10), but still far less than the Alvord Basin proportion.

To answer this question we must look at the differences between the two areas covered by the Steens lowland survey and that within the Alvord Basin survey. The latter project surveyed a total land area of 61 square miles, all in lowland areas and restricted to BLM land, generally not including the most well watered land in the valley, most of which is in private ownership. Survey coverage was very extensive, amounting to just over one-third of BLM land in a project area 34 miles long by 21 miles wide. Most land in the Alvord Basin is owned by the BLM, so the survey appears to be well representative of the Alvord lowlands, with the proviso (as pointed out by Pettigrew [1975:26]) that the highest site density, and possibly the largest

Table 5.13. Projectile Points by Type from the TCOCU Project, the Alvord Basin Survey, and the Steens Mountain Survey.

	TCOCU		ALVORD SURVEY		STEENS UPLANDS[1]		STEENS LOWLANDS[2]		ALVORD LOWLANDS[3]	
TYPE	ct.	%	ct.	%	ct.	%	ct.	%	ct.	%
SSN/UST	3	6.1	12	3.7	26	3.6	25	4.7	13	4.8
RG*	7	14.3	89	27.3	184	25.2	109	20.3	34	12.7
ELKO	12	24.5	53	16.3	213	29.2	168	31.3	75	28.0
GATECLIFF**	15	30.6	21	6.4	116	15.9	93	17.3	56	20.9
HUMBOLDT	9	18.4	33	10.1	113	15.5	75	14.0	40	14.9
LSN	3	6.1	9	2.8	74	10.1	59	11.0	42	15.7
EARLY	0	0.0	109	33.6	4	0.5	8	1.5	8	3.0
TOTAL	49	100.0	326	100.0	730	100.0	537	100.0	268	100.0

* for Steens Project, includes "Small Stemmed"
** for Steens Project, includes "Large Stemmed"
[1] Steens Project uplands total
[2] Steens Project lowlands total
[3] Steens Project, Alvord lowlands only

sites, should be expected on private land, especially along the western side of the valley, which receives runoff from Steens Mountain.

The Steens Mountain project had an upland orientation, centering on Steens Mountain itself and covering the lowlands that were adjacent to the upland block. Furthermore, the project area was defined as a north-south oriented rectangle placed over a mountain ridge oriented south-southwest to north-northeast (Beck 1984; Jones 1984). As a result, the Alvord lowlands sample of the project occupied mostly the southeastern sector of the project rectangle, which includes a very special part of the Alvord lowlands, much of which is on private land, and much of it not covered by the previous Alvord Basin project. This lowland area, a wedge 21 miles long by a maximum of 8 miles wide, is only a small fraction of the Alvord Basin lowlands, but one centering on Alvord Lake, which is fed by the two most substantial streams in the Alvord Basin, Wildhorse Creek, draining the south flank of Steens Mountain, and Trout Creek, arising in the high Trout Creek Mountains to the southeast. Alvord Lake, when full, drains into the Alvord Desert playa to the northeast. It seems clear that the portion of the Alvord lowlands chosen for survey by the Steens Mountain project is among the most well watered areas of the Alvord Basin, and would especially be so during wet climatic episodes. Furthermore, much of the Steens lowlands sample comes from the Catlow lowlands southwest of Steens Mountain, for which the Steens Mountain project has collected the only significant amount of data. This Catlow lowlands sample is not representative of the entire Catlow lowlands, of which it is only a fraction in the southeastern quadrant. As with the Alvord lowlands sample, the Catlow lowlands sample appears to include some of the most well watered portions of that lowland valley.

The Alvord survey data in Table 5.13 differ from the Steens project lowlands data not only in terms of the Early group, but also in regard to LSN, Humboldt, Gatecliff, Elko, and Rosegate point frequencies. The Alvord survey recorded far fewer LSN points than the Steens project lowlands (significant at .001 level), along with somewhat fewer Humboldt (significant at .10 level), far fewer Gatecliff (significant at .001 level), far fewer Elko (significant at the .001 level), and significantly (at the .05 level) more Rosegate points. Restricting the comparison purely to the Alvord Basin, the differences between the Alvord Basin survey data and those from the Steens project (Alvord lowlands only) are similar to and in some cases greater than those just described, because of significant differences between the Steens project Catlow and Alvord lowlands samples. Such is the case in four important instances: (1) Early points are more frequent in the Steens project Alvord lowlands sample (3.0%) than in the Catlow lowlands sample (0%) (difference significant at .01 level); (2) LSN points are much more common in the Alvord lowlands sample (15.7%, but 24 of the 42 points in the sample come from one site on the northeastern margin of Alvord Lake) than in the Catlow lowlands sample (6.3%) (difference significant at .001 level); (3) Gatecliff series points are more numerous in the Alvord (20.9%) than in the Catlow lowlands (13.8%) (difference significant at the .05 level); and (4) the Catlow lowlands have a much higher percentage of Rosegate points (27.9%) than the Alvord lowland sample (12.7%) (difference significant at well beyond the .001 level).

These differences, in combination with the temporal estimates of Figure 5.18 and the geographic differences just described between the Steens Mountain and Alvord Basin survey areas, suggest strongly that there was a great deal of clustering of human economic activity in the well watered lowlands immediately adjacent to Steens Mountain during the middle Holocene, after the eclipse of the Western Pluvial Lakes Tradition (WPLT) at ca. 7000 B.P. Some hint of such clustering comes from the analysis of the Alvord Basin survey data by Pettigrew (1984:80), who points out the unusual concentration of LSN points on the bottomland between Alvord Lake and the Alvord Desert playa, and suggests that this pattern may reflect mid-Holocene desiccation and reduction of population density following the disappearance of the lowland marshes. With the addition of the Steens Mountain project data, it now appears that this interpretation was on the right track, and that lowland occupation during that time may have retreated to the most well watered locations, particularly the Alvord Lake vicinity. Put another way, the orientation toward lakes and marshes that characterized the WPLT may have persisted throughout the middle Holocene in the sense that lowland habitation continued to concentrate around bodies of water such as Alvord Lake.

Besides a post-7000 B.P. concentration of human activity in the Alvord Lake vicinity, the Alvord lowlands data from the Steens Mountain project show a significantly (at the .001 level) lower proportion of Rosegate projectile points than the Alvord Basin survey, suggesting that focused economic use of the Alvord Lake vicinity tapered off after 2000 B.P. in favor of a more widespread lowland pattern possibly concentrating at springs instead of lowland lakes and marshes. Such a shift may have been in response to reduced effective moisture and reduced dependability of Alvord Lake and its tributary streams (land-use patterns in association with paleoclimatic data are discussed below).

Within the broader context just outlined, prehistoric human use of the TCOCU project area stands out in its relatively large proportions of Humboldt series (greater than the Alvord Basin survey at the .10 level) and Gatecliff series (greater than the Alvord Basin survey at the .001 level, greater than the Steens uplands sample at the .01 level) points. Furthermore, and at opposite ends of the temporal scale, are noted the absence of Early group points (lower than the Alvord Basin Survey at much below the .001 level) and relatively low proportion of Rosegate series points (lower than both the Alvord Basin and Steens Mountain uplands samples at the .10 level). The proportion of LSN points from the TCOCU project is greater than that recorded for the Alvord Basin survey, and lower than both the uplands and lowlands samples for the Steens mountain project, but not statistically significantly different from any of those samples. Reference to Figure 5.18 suggests that the period of most intense use of the TCOCU was from about 4000 to 2000 B.P., with greatest emphasis possibly in the first half of that time (fourth millennium B.P.), when the Gatecliff series appears to have been at its peak. No Early points were found, though limited numbers of such specimens were found by Hattori (1980) and Minor (1980). Use of the TCOCU during the WPLT appears to have been light. Somewhat increased use of the area seems to have begun at some time between 7000 and 4000 B.P., as indicated by the LSN points recorded by our survey and by Hattori (1980) and Minor (1980). Following the peak period of use from 4000 to 2000 B.P., land-use intensity appears to have declined to something like half of its former level, but still much more than the area experienced during the WPLT, and probably more than it saw during the transitional period of 7000-4000 B.P.

It may be instructive to compare evidence for changing land-use intensity in the TCOCU and adjacent areas with the excellent paleoenvironmental record for the Steens Mountain area recently presented by Mehringer (1985) and Wigand (1987). The record before about 6000 B.P. comes from pollen cores in Fish Lake and Wildhorse Lake on Steens Mountain (Mehringer 1985), to which may be added for the remaining period the pollen sequence from Diamond Pond just north of Steens Mountain (Wigand 1987). Prior to 8300 B.P. the evidence indicates relatively high effective moisture at Fish Lake, at about the same elevation (2250 m) as the high tableland of the TCOCU. At about 8300 B.P., an increase in sagebrush pollen indicates a significant drop in effective moisture there which lasted until about 5300 B.P. Diamond Pond had a low and ephemeral water level until about 5400 B.P., when it became a perennial pond, reflecting an increase in available moisture. The period of greatest effective moisture there was from 4000-2000 B.P., and the deepest late-Holocene pond existed there at about 3700 B.P. Reduced effective moisture occurred again between 2000 and 1400 B.P., followed by a wet period from 1400 to 700 B.P. With the exception of the period 300-150 B.P., the time since 700 B.P. has been characterized by reduced effective moisture, including distinct droughts at about 700 and 500 B.P.

Although it must be done with reservation, we may associate the archaeological with the paleoclimatological record. It would be naive to suggest that climatic and cultural change march together in military fashion, but any model of cultural change must take into account the economic stresses and opportunities potentially caused by environmental alteration. Taking as our basis the model of prehistoric land use proposed by Pettigrew (1984) for the Alvord Basin, and modifying it as appropriate, changing climate appears to have played a key role in the sequence of cultural change exhibited by the archaeological record. The model is composed of four adaptive modes, which are conceived to be extractive economic systems differing from one another in terms of settlement patterns, preferred foods, scheduling of economic activities, and (to a varying extent) technology. In order, these adaptive modes are Paleo-Indian (12,000-11,000 B.P.), Western Pluvial Lakes Tradition (11,000-7,000 B.P.), Transitional Archaic (7,000-5,000 B.P.), and Full Archaic (5,000 B.P.-contact). No evidence for the first of these, the Paleo-Indian mode, characterized by small bands of fully nomadic foragers specializing in large herd animals and using large fluted spear points, was found in the TCOCU. This mode had a lifeway poorly suited to the use of upland zones, except perhaps around upland lakes and marshes where large herbivores could be found. Near the TCOCU, the best evidence for this mode is the collection of fluted points from the Alvord Basin survey (Pettigrew 1975, 1984), along the edge of what probably was a large marsh or lake at that early time, while the pluvial lakes of the Pleistocene still occupied the lowland basins.

The Western Pluvial Lakes Tradition, like the Paleo-Indian mode before it, appears, as the name implies, to have been associated with the remnants of pluvial lakes that persisted after the end of the Pleistocene, and is identifiable by the Early group of projectile points. It is thought that the end of the Paleo-Indian mode came about when the large herd animals (especially the mammoth, but possibly including the horse and large bison) had been decimated, and it became necessary to focus on a more reliable and diverse set of resources, including a variety of plants and animals on the still-wet bottomlands. Base camps were located on the margins of lakes and marshes, and seasonal hunting and gathering zones were limited mostly to lowland areas, since ecozones still had not risen to substantially higher elevations and food sources in the lowlands, including big game, waterfowl, and vegetable foods, were dependable and abundant. Use of upland areas such as the TCOCU and the Steens Mountain uplands evidently was slight. Human populations in the lowlands, as suggested by the very high numbers of Early points found by the Alvord Basin survey (Pettigrew 1975, 1984), at Coyote Lake (Butler 1970; Southard 1969), and in the Black Rock Desert (Clewlow 1968), appear to have been quite substantial, probably as much as any later period. The abandonment of this lifeway may have occurred as early as 8000 B.P., rather than 7000 B.P. as previously proposed, if the lakes and marshes upon which the human populations and their food sources depended disappeared at that time, as one might infer from Mehringer's (1985) data. The rate of decline of such bodies of water likely would have depended on factors such as latitude, elevation, characteristics of their drainage basins, and their size, and some lakes and marshes probably would have lasted longer than others.

The Transitional Archaic mode, as the name implies, is thought to have been an attempt to find ways to adapt to dramatically changed environmental conditions (the loss of the last large herd animals and the substantial reduction of low elevation wetland resources) following the onset of mid-Holocene desiccation. Previously (Pettigrew 1984:84), it was hypothesized that the initial adaptive change was a shift to higher elevations to collect foods used previously by the WPLT, but evidence from the Steens Mountain project and from the TCOCU makes that option seem less likely. Instead, it now appears that human populations maintained their home bases in the lowlands, merely relocating their lowland settlements to the most favorable remnants of the formerly abundant lakes and marshes. At the same time, the annual economic round began to include regular trips to upland areas to hunt the remaining, but largely solitary, large mammals with notched projectile points, and the collection of vegetable foods became more labor-intensive, with the expanded use of dryland seeds and roots that required processing through grinding on metates and in mortars. Seeds and roots, in fact, eventually became the staple foods. Technological innovation, expansion of band territories, and a substantial reduction in human population densities characterized this period. By its conclusion at about 5000 B.P., the subsistence economy had been revolutionized, artificially increasing the carrying capacity of the landscape even in the absence of increased moisture, and human populations had rebounded somewhat from their low numbers earlier on.

LSN projectile points, which seem best to represent the Transitional Archaic, have been shown by the Steens Mountain project (Beck 1984) to be most common in the Alvord Lake vicinity, though elsewhere in the Alvord Basin lowlands they generally are rare (Pettigrew 1984). This is the tightest areal clustering of any major projectile point type in the Alvord Basin. Further, LSN points are the earliest group to be substantially and widely represented in upland zones, including the TCOCU (Table 5.13). This evidence supports the hypothesized shift in lifeway that is the hallmark of the Transitional Archaic.

The last adaptive mode proposed by Pettigrew (1984) is the Full Archaic, thought to have begun at about 5000 B.P. The subsistence strategy that had evolved during the Transitional Archaic, particularly with its dependance on seeds and roots, was very adaptable to changing environmental conditions, which can cause serious fluctuations in the availability of game. Wintertime food storage now facilitated larger winter settlements, which were still located at the most well watered locations. Seasonal camps were maintained at distances from the central settlements in the vicinity of key resources such as root and seed gathering grounds, lithic quarries, and upland hunting territories. The degree of sedentism is unknown in the region surrounding the TCOCU, since no winter settlements have been identified and investigated. When increased effective moisture finally arrived around 5000 B.P. (and more substantially around 4000 B.P.), the Full Archaic adaptive mode was in a position to take full advantage of it as a result of improved efficiency developed during the leaner times of the mid-Holocene. Human populations increased markedly, leaving a much greater imprint on the archaeological record, and reaching a maximum between 2000 and 3000 B.P. During the drier intervals following 2000 B.P., lowland settlements appear to have shifted to some degree from the margins of formerly dependable but now intermittent lakes and marshes (such as Alvord Lake) to more dependable but smaller springs, resulting in a more dispersed arrangement of lowland settlements. Population density appears to have declined somewhat during these times.

Upland utilization, as evidenced both in the TCOCU and the Steens Mountain uplands, clearly was at its peak during the Full Archaic. The most important upland subsistence activity probably was the hunting of deer, bighorn sheep and possible antelope. The TCOCU and the Steens Mountain uplands differ in the peak periods of use represented by the projectile points, however. The large numbers of Gatecliff points in the TCOCU seem to point to the greatest use during the fourth millennium B.P., while the largest numbers of points on Steens Mountain are from the Elko and Rosegate series, suggesting heaviest use after 3000 but before 1000 B.P. We cannot be sure why this difference occurs, but it may result from important geographic differences between the two upland areas combined with the effects of human hunting pressure. Steens Mountain is much larger in total upland land area, and has a significantly greater maximum elevation, reaching nearly 10,000 feet as opposed to only 8000 feet for the TCOCU. Furthermore, the best herbivore habitat in the TCOCU is on the flat tablelands that have limited surface areas constricted by the numerous canyons, while Steens Mountain possesses much larger areas of grazing land where animals may disperse. For these reasons, human hunting pressure probably has a greater potential impact on population levels of large herbivores in the TCOCU than on Steens Mountain. Thus, the expanding human population of the Full Archaic may have been very successful initially at hunting in the TCOCU, but at the eventual expense of the animal populations, which were larger and better protected from human predation on Steens Mountain. Furthermore, the effects of drought, especially after 2000 B.P., would have been more serious for large herbivores in the TCOCU, with its lower elevations, than on Steens Mountain, where higher elevation means more dependable water supplies.

Combining the explanatory model with the recently collected evidence from the TCOCU, we can assess the kinds of uses to which this upland area was put by the prehistoric population as well as the range of functions likely to be represented in the archaeological sites. As stated above, the most important subsistence activity in the TCOCU appears to be the hunting of the large herbivores. Although we might have expected to find more grinding tools (mortars and pestles, manos and metates), the discovery of only one (a mortar in a rockshelter) makes it clear that the collection and processing of seeds or roots were secondary activities at best. Why this should be so is not clear, particularly in the absence of information regarding the presence and productivity of food plants in the area. It may be that important food plants, such as those described by Couture et al. (1986), are poorly represented and thus are not an important attraction. Whatever the explanation, archaeological sites in the TCOCU appear to represent aspects of two main pursuits: hunting and the procurement of lithic raw material.

It has been pointed out (Pettigrew and Spear 1987:59) that ". . .'hunting' is not a single activity, but rather an extractive pursuit that involves a variety of specific activities, each of which may leave its particular signature in the archaeological record." Such specific activities may include tool manufacture, tool maintenance, ambush, butchering (often done in two loci -- field and camp), cooking, and bivouacking. Further, raw material procurement is easily embedded within hunting activities (Binford and O'Connell 1984). These considerations and our knowledge of the general nature of prehistoric sites in the area, then, suggest that the specific functions of sites may fall within the range of activities suggested above. Some sites are likely very short-term loci representing a single activity (and perhaps a single episode), while others are more complex. The most complex sites in terms of the range of activities carried out and the variety of remnant evidence should be the rockshelters, prime locales for bivouacking and thus convenient locations for most of the other activities as well. We would expect also that at least some of the main lithic source sites contain evidence for relatively wide range of activities, because of the frequency and importance of their use. A reasonable model for the prehistoric exploitation of the TCOCU would make the rockshelters prime candidates for base camp locations from which were carried out day trips to resource areas. Other base camps may exist also on upland canyon bottoms and in sheltered spots along the ridgelines and upland flats. Hunting and raw material gathering in the uplands probably took place primarily during the warmer period of the year, when the populations of large herbivores concentrated in the higher pastures.

Some changes in the nature of upland exploitation after 2000 B.P. may be indicated by the evidence on raw material use. As discussed above, with the introduction of the bow-and-arrow came a reduction in the use of Whitehorse obsidian for projectile points, and a corresponding increase in the use of other obsidian sources and CCS. A key question is whether this change is coincidental or is the result of the changing technology. It seems possible that the reduction in the size of projectile points lessened the demand for large flakes (needed to produce the large blanks required for Gatecliff and Elko series points), and thus reduced the importance of those sources that could produce large flakes. According to this explanation, nearer sources yielding smaller but sufficiently sized flakes could now be used preferentially. Such sources could include older archaeological sites.

A similar pattern of changing raw material use is reported by Hanes (1988:146-151) for Dirty Shame Rockshelter. There, obsidian was used extensively in zones prior to the introduction of Rosegate series points, but drops markedly in comparison with CCS in the later deposits. At the same time, the variety of obsidian used declines, and the more distant sources become much less common. Hanes suggests that the explanation is to be found in an increase in the degree of sedentism (and a reduction in mobility) in the later zones. The technological explanation suggested above, however, would work here as well.

Hughes (1986) has conducted a systematic study of obsidian source utilization through time in south-central Oregon and northeastern California. His results in all of the areas studied fall in line with patterns already described. In each case the advent of the arrowpoint co-occurs with the contraction of obsidian use to the nearest sources. Again, this pattern can be explained technologically, as suggested above. Further, the widespread nature of the pattern makes it seem less likely that it is caused by an increase in sedentism and reduction in mobility, since such changes in settlement patterning are less likely to be regionally synchronous than are the technological changes wrought by the introduction of the bow.

Returning to the TCOCU, the reduction in the use of Whitehorse obsidian following 2000 B.P., whether caused by the technological requirements of the arrowpoint (the preferred explanation) or by reduced residential mobility, appears to signal a diminution in the importance of raw material collecting (at least with regard to obsidian) in relation to hunting activities. Points apparently were more frequently brought to the area by hunters, and less frequently made there. It is even possible that the overall reduction in use of the TCOCU after 2000 B.P. was caused by the reduced importance of Whitehorse obsidian. There may have been just that much less incentive to travel up into the area.

One might well ask how applicable is the proposed evolutionary model of changing land use, which seems to account well for the data available so far from the TCOCU and the Steens Mountain-Alvord Basin area, to adjacent areas, particularly the Owyhee Uplands to the east. We believe that the applicability there is generally quite good, but that important, mostly geographic, differences must be taken into account. The model was designed on the basis of data gathered from closed basins and adjacent uplands, so characteristic of the northern Great Basin. The Owyhee Uplands differ from such areas particularly in the relative lack of closed basins, the relative infrequency of lakes and marshes, and the vast expanses of canyon-dissected tableland unbroken by distinct mountain ranges. The Owyhee Uplands are a part of the Columbia River drainage system, and salmon were an important food resource ethnographically (Plew 1985). The two most well known archaeological sites in the Owyhee Uplands, Dirty Shame Rockshelter and Nahas Cave, are actually at fairly low elevations by Great Basin standards (Dirty Shame Rockshelter at 4700 feet, Nahas Cave at ca. 4900 feet), and thus may not accurately be called upland sites.

Given the lack of pluvial lakes in the area, the model would suggest rather limited human use of the Owyhee Uplands in the early Holocene, and the evidence supports this prediction. Plew (1985) finds very little trace of human occupation earlier than about 6000 B.P. in the Owyhee River drainage of Idaho. At Dirty Shame Rockshelter, Hanes (1988:145-146) documents only very limited occupational intensity prior to 6800 B.P. Much less well known is the survey of the Owyhee Uplands by Hubbard (1967), who reports on 13 sites, none of which produced projectile points clearly earlier than the LSN type (considered here to be most common following 7000 B.P.).

The model would further suggest that the expansion of resource territories into formerly little used zones in the Transitional Archaic would be reflected by the appearance of LSN points as the earliest indicators of intensive human use. Hubbard (1967), as indicated above, offers evidence supporting this prediction from the Owyhee River, where site 35ML7 is dominated by LSN points. LSN points are the earliest notched points stratigraphically at Dirty Shame

Rockshelter (Hanes 1988:145), where they are far more common than those that could be grouped as members of the Great Basin Stemmed series. Also of interest is the fact that the increase in occupational intensity experienced at that site is accompanied by an increase in plant food collecting, as would be predicted by the model. Though only two LSN points were found at Nahas Cave (Plew 1986:63), they are among the earliest point types found there among the rather limited collection. Thus, evidence is not overwhelming, but it does support the model.

The evidence supports the model also in that the greatest intensity of occupation in all the investigations undertaken so far comes during what can be seen as the Full Archaic. One potentially important difference from the TCOCU-Steens Mountain vicinity, however, is that occupational intensity in the Owyhee Uplands seems to peak within the last 2000 years (represented by the Rosegate series) rather than in the period from 4000 to 2000 B.P. (represented by the Elko and Gatecliff series). The meaning of this pattern is unclear, especially since it seems likely that the rate of production of arrowpoints (Rosegate) was greater than that for atlatl dart points (Elko and Gatecliff). It is also noted that the Alvord Basin survey (Table 5.13) recorded far more Rosegate than Elko or Gatecliff points, though this fact may largely reflect the concentration of pre-Rosegate lowland occupation in the Alvord Lake vicinity. Nevertheless, it seems distinctly possible that the positive effects of the 4000-2000 B.P. moist episode on human populations were not as strongly felt in the canyonlands of the Owyhee Uplands as they were in the closed basins to the west, and, conversely, that the dispersive effects of the post-2000 B.P. dry periods resulted in more intensive use of the well watered canyons of the Owyhee Plateau.

EVALUATION OF RESULTS

The results of the TCOCU survey project are very encouraging, since they have generated a new and substantial body of data that can be seen to manifest many valuable patterns. An important consideration in the assessment of these results is their reliability. To what extent can we trust the patterns observed, and confidently use them as the basis for our interpretations and for the future management of cultural resources in the project area?

To answer the question conclusively may not be possible, but it can be addressed with reference to the various kinds of results obtained by this project. First of all, the environmental analysis made possible by the encoding of environmental data relied upon available BLM and USGS maps. The environmental analysis thus is no more reliable than the maps. In our view, the USGS maps, which we used in the field to find and record our locations, are excellent and contain remarkably few errors, though they do not provide some kinds of information (such as the location of rimrock, which is given on the BLM maps). The BLM 30 minute series maps, however, were found lacking in many respects, and are not considered reliable enough for some purposes. On these maps, it is common to find streams and roads located as much as one-quarter mile from their true positions, and the extent of rimrock given on the maps was found during our field reconnaissance often to be quite inaccurate.

Our dependence on the BLM maps was limited, however, and the environmental database is considered to be quite accurate, with errors confined mostly to the rimrock category.

Because our survey covered only 1.7% of the project area, the selection of quadrats for the survey sample takes on particular importance, since the goal was to generalize about the project area on the basis of the sample. As discussed in Chapter 4, survey quadrats were selected so as to slightly bias the results toward higher discovery rates. Dividing the total project area into equivalent numbers of quadrats of high and low predicted land-use intensity (or "probability"), we selected 12 low and 24 high probability quadrats (as listed in Table 4.4) for field inspection. After analysis of the survey results, and revision of the predicted land-use intensity formula (and the creation of the new land-use intensity value I_7), some shifts between the high and low probability groups occurred among the surveyed quadrats. Specifically, one quadrat (38-40-11-NW) moved from the low to the high value group, and three quadrats (40-39-14-SE, 41-39-18-SW, and 41-39-5-SE) shifted from high to low values. The result is that, based on the new I7 values, 14 surveyed quadrats are in the low and 22 in the high probability group, a net shift of two quadrats (totaling 240 out of the sample of 5000 acres) from high to low probability. This change is rather small, and serves to make our surveyed sample more rather than less representative of the total project area.

The sampling design involved every possible effort to assure representativeness. As described in Chapter 4, the project area was stratified in terms of elevation and drainage area, and survey quadrats were randomly selected so that the surveyed sample closely approximated the areal percentages of the project area within each of the 12 strata so defined (see tables 4.2 and 4.3). The actual acreage selected for survey within each sampling stratum differs only very slightly from the ideal sample proportion. The amount of land actually surveyed, 5000 acres, is just 1.7% of the total project area, a percentage less than the 5% accomplished for the Steens Mountain project (Beck 1984; Jones 1984). Such a percentage leaves room to question the degree of representativeness of the sample, for sampling error surely increases as a potentially biasing factor with smaller samples. The best way to determine the degree of representativeness of this sample would be to survey another sample from the same project area and compare the results. Until that is done, we can only be sure that we have maximized the representativeness of the sample by the means described above.

There is one environmental factor, the presence of toolstone raw material, that we know to be important but have not been able to take into account in our environmental analysis and predictions of land-use intensity. As pointed out earlier, natural obsidian is commonly found throughout the project area, and large areas of natural cryptocrystalline silica can be found in the southern sector. Our own data and those from Hattori (1980) and Minor (1980) strongly indicate that the presence of such lithic sources associates with clustering of prehistoric sites, yet we are unable to specify where these sources are without a ground search. The distribution of lithic sources is likely to be responsible for much of the variability that our analysis, using the environmental variables that one can record from existing maps, did not account for.

The accuracy of our field data is another important consideration. We adopted for this project a new method of recording field data, involving the logging of the counts of cultural items observed within each 30 m segment of each survey transect. Based on our results (see Appendix B), we feel confident in concluding that we have been able to report the distribution of field data with greater accuracy and efficiency than has been possible before in southeastern Oregon. Most survey projects conducted previously recorded only the locations of what were defined as sites (e.g., Hattori 1980; Minor 1980; Pettigrew 1975), the distributions of which were illustrated on maps. Off-site data most often have not been reported, or are reported only anecdotally. At the other end of the scale, Beck (1984) and Jones (1984) document the detailed plotting of individual specimens found during the Steens Mountain project survey within 15 m squares in off-site areas. Since that project used 15 m transect intervals, the database there possesses even better resolution of surface patterns than the TCOCU project. This resolution is of rather little use to us, however, since the distributional data from that project are not reported except in terms of sites. The distributional data from the TCOCU project, which are slightly grainier but still of quite high resolution, are reported in this volume (Appendix B) for both site and off-site areas, and thus can be used for research and management purposes. Furthermore, "site" was defined in terms of an objective measure that allows direct comparison of site and off-site data.

Our confidence in the accuracy of the field data is tempered somewhat by the recognition of factors beyond our control that inevitably influenced the record. Vegetation, which generally was sparse, occasionally was thick enough to affect surface visibility, and thus reduced the counts of cultural items in those locations. Geologic factors, such as alluvial and colluvial action and wind erosion, no doubt obscured to some degree the original patterns of deposition of cultural items. Cattle almost certainly have moved cultural debris about to some extent. There may have been some variability among field crew members in terms of their visual acuity or other skills, though daily shifts in crew composition were made to mitigate systematic bias. Time of day and weather conditions may have influenced the visibility of objects on the surface. Despite these factors, however, we have every reason to believe that the record made by the TCOCU survey constitutes a very accurate reflection of what was visible on the ground at the time the survey was done, and that the standards set for this project were quite high.

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6. SUMMARY AND CONCLUSIONS

With the results of the TCOCU archaeological survey project now described and analyzed, it remains to synthesize the information presented so far, and to discuss its uses for future management and research. This chapter is divided into two sections to accomplish those purposes. The first section synthesizes the project's results, so as to allow quick and easy assimilation of the principal elements. The second section presents estimates of the magnitude and distribution of cultural resources for the entire project area in the context of management needs and considerations, discusses the research potential of the project area, and offers a set of recommendations for future inventory and investigation.

SYNTHESIS

Archaeological survey of 5000 acres of the 287,000-acre TCOCU project area has produced a body of data well suited to interpretations of human land use patterns and to the pro-active management of cultural resources. The survey sample was chosen following the compilation of a geographic database for the project area. The authors developed the database by extracting data on key environmental variables from USGS and BLM maps for quarter-section (160-acre) quadrats containing BLM land, of which there are 1889 in the project area, and applied a hypothetical formula using the variables to generate an estimate of human land use intensity for each quadrat. The population of potential survey quadrats was stratified in terms of elevational interval and drainage area, and 36 survey quadrats randomly chosen to closely approximate the relative proportions of the 12 strata through the project area. The chosen sample also was biased somewhat in the direction of greater predicted land use intensity, so as to improve the chances that a substantial body of data on cultural resources would in fact be recorded.

Conduct of the field survey involved the use of 30 m transect intervals, and a method of data recordation whereby counts of cultural items were logged for each 30 m segment of each transect. With some exceptions, localities containing 10 or more cultural items within a 30 m transect interval were labeled as archaeological sites. Collection of objects included only temporally diagnostic projectile points.

Compilation of the geographic database allowed analyses and tabulations of project area information that otherwise would have been impossible. For example, analysis has shown that, as one proceeds from the lower to the higher elevations, intermittent streams become much less common, permanent streams tend to increase slightly, and rimrock, ridgeline and springs increase substantially. A major exception in the north drainage is an actual tendency for rimrock to decline at the higher elevations, owing to the unique physiography of the tilted fault block. Topographic variability within surveyed quadrats ranges from 60 to 1090 feet. The mean elevational range within quadrats varies systematically by elevational interval, from 143.3 feet for the 4000-5000 foot interval to 544.5 feet for the 6000-7000 foot interval.

Rimrock is most plentiful for the 6000-7000 foot interval, and least common for the elevations below 5000 feet. Sources of permanent water are present in 58.3% of the surveyed area above 7000 feet, 47.6% of the surveyed area in the 6000-7000 foot interval, 22.2% in the 5000-6000 foot interval, and 29.4% of the area below 5000 feet. In the southern drainage area, 44.4% of the surveyed acreage has a water source, but this variable drops to 37.7% for the northern area, and 22.2% in the eastern drainages.

Naturally occurring obsidian occurs throughout the project area, and was found in 12 of the 36 surveyed quadrats. Obsidian distribution is heavily biased toward the higher elevations, occurring in 91.6% of the surveyed area above 7000 feet, 54.8% of the area between 6000 and 7000 feet, 16.6% between 5000 and 6000 feet, and in none of the quadrats surveyed below 5000 feet.

Of the 78 archaeological sites found, 57 (73%) are lithic scatters, 13 (17%) are rock features (mostly rock cairns), six (8%) are rockshelters, and two (2%) are obsidian sources. The rock features most likely are historic sites, while the remainder are all prehistoric. Lithic scatters range in size from 9 to 54,000 m^2, and range in density from 10 to 1000 specimens per 100 m^2. Fifty-three (93%) of the lithic scatters are primarily of obsidian, while three are primarily of CCS, one is of basalt, and one site is divided between obsidian and basalt. Most tools observed were projectile points or other formed bifaces. Most lithic scatters (38, or 67%) are on deflated surfaces, with no indication of subsurface deposits. Two such sites are on alluvial soils and are likely to have buried components. Buried cultural deposits may or may not be present in the remaining lithic scatter sites.

All of the six rockshelters appear well preserved and unaffected by vandalism, and all probably have subsurface cultural deposits. These sites, though the counts of artifacts on the surface were low, displayed greater assemblage diversity than the lithic scatters, and five of the six possess charred faunal remains. This evidence suggests that the rockshelters were used as temporary habitations or base camps.

The two sites classed as obsidian sources (or quarries) had the highest densities of lithic debitage observed in the project area, up to 5000 items per 100 m^2 at one and 200 items per 100 m^2 at the other, and among the greatest surface areas (54,000 m^2 and 1800 m^2, respectively).

Some distinct locational tendencies were noted for archaeological sites. Rock features cluster heavily in the south drainage area, where mining activity has been greatest. Lithic scatter sites are twice as common above 7000 feet than at lower elevations. Distance to water increases with elevation for lithic scatters, but decreases for rockshelters. Ridgetops by far are the favored locations of sites. All rockshelters were found at the base of rimrock, but no lithic scatters were found there. Five of the six rockshelters were found adjacent to major ridges and overlooking steep canyons.

Surveyed quadrats varied greatly in their content of cultural resources. Many quadrats had no sites, but one had 13. Total site area within quadrats with sites ranged from 33 to 120,295 m^2. Debitage counts among all quadrats ranged from 1 to 32,981 items. Debitage observed in the field varied widely in basic technological characteristics, including size range, percent with cortex, and raw material.

Fifty-four classifiable projectile points were found, the most numerous of which (11, or 20.37%) are those of the Gatecliff Split Stem (GSS) type. The two most numerous temporal groups are the Gatecliff series (15, or 27.78%) and the Elko series (12, 22.22%). Most of the collection consists of the larger, broad-necked atlatl dart points, two-thirds of which appear to be made of the local Whitehorse obsidian, one-third of other obsidian, and none of CCS. The smaller, narrow-necked arrowpoints, however, are much less commonly made of Whitehorse obsidian and much more frequently made of CCS and other kinds of obsidian. Projectile point neck width was found to be clearly bimodal, reflecting the division between arrow and atlatl dart points. Type GSS, surprisingly, possesses two modes itself, suggesting the existence of a third and higher mode above 15 mm that may reflect the use of the knife or thrusting spear.

A major analytical effort was devoted to a test of the reliability of the predicted land use intensity, as measured by recorded data such as the count of sites, total site area, and numbers of cultural items within surveyed quadrats. The original formula for land use intensity correlated quite significantly (r=.44) with the count of prehistoric items (considered the most reliable measure of land use intensity), but at a level lower than what was considered possible and desirable. By modification of the form of the equation, the addition of elevation as a key environmental variable, and adjustment of the parametric factors, the correlation was raised substantially, to r=.73. The parameter revised most markedly was that weighting the length of ridgeline (LRD), which was found to be by far the most important governing variable at the higher elevations, though length of permanent stream (LPS), originally thought to be of primary importance throughout, was shown to be of greatest importance at the lower elevations. The count of sites and total site area were found correlated highly (r=.62 and r=.63, respectively) with the new intensity formula, but, as expected, at levels below that obtained for the count of prehistoric items.

When tested against data collected by previous surveys (Hattori 1980 and Minor 1980) in the TCOCU, the formula was found to produce essentially no correlation. Unfortunately, the earlier data constitute a poor test of the reliability of the formula, since they possess little environmental heterogeneity, are concentrated in a rather small portion (in the southern area) of the TCOCU, and are strongly associated with lithic (obsidian and CCS) sources. Further, since no counts of items were reported for these projects, we were forced to use the site count as the measuring variable, and Hattori (1980) appears to have used a more liberal site definition than the TCOCU project.

Chronological appraisal of the collected projectile points indicates little use of the project area prior to 7000 B.P., a small increase in intensity between 7000 and 4000 B.P., a major peak in intensity between 4000 and 2000 B.P. with some emphasis on the first half of that interval, and a notable decline in land use after 2000 B.P. The temporal pattern displayed supports the land use model proposed by Pettigrew (1984), which is modified somewhat on the basis of the regional review conducted through this project. This model holds that human occupation during the Paleo-Indian (12,000-11,000 B.P.) and Western Pluvial Lakes Tradition (WPLT, 11,000-7,000 B.P.) adaptive modes clustered in the lowlands, largely around the margins of lakes and marshes. Human populations reached an early peak during the WPLT. A major adaptive transformation occurred during the Transitional Archaic (7,000-5,000 B.P., but beginning possibly as early as 8,000 B.P.), after the lowland lakes and marshes dissipated, when human populations declined considerably, lowland settlements clustered around the remnant areas of plentiful fresh water, intensive use of the upland zone began, and the grinding of seeds and roots became an essential part of subsistence. Finally, in the Full Archaic (5,000 B.P.-contact), human populations, now with a more efficient technology and economic system, were able to respond to improved moisture conditions with a dramatic increase in population density that left a clear mark on the archaeological record, in both the uplands and the lowlands. The best represented period in the TCOCU, 4000-2000 B.P., is seen as the reflection of the greatest period of success of the Full Archaic, when moisture conditions have been shown to be at their most favorable, and when populations of deer and bighorn sheep, the likely prey and a major attraction of the TCOCU, may have been at their peak.

Human use of the TCOCU appears to be dominated by hunting and lithic raw material procurement, and only slight evidence was found for the collection of plant foods. Thus, prehistoric sites in the area probably reflect one or more of a variety of possible functions, from single use (and possibly single episode) open sites to rockshelters that may have functioned as base camps where a great variety of tasks were carried out. Evidence for reduced use of Whitehorse obsidian and correspondingly greater use of other obsidian and CCS among the projectile points after 2000 B.P. fits with data from Dirty Shame Rockshelter as well as areas of south-central Oregon and northeastern California, and may reflect a reduced demand for large flakes and large cores following the introduction of the bow-and-arrow.

The proposed land use model appears to have applicability mostly in the northern Great Basin, particularly from the TCOCU to Steens Mountain, but is supported also in general terms by data from the Owyhee Uplands of southeastern Oregon (Hanes 1988; Hubbard 1967) and southwestern Idaho (Plew 1985e, 1986). The Owyhee Uplands, however, are distinct in important ways geographically from the Basin and Range Province, and thus can be expected to differ also in terms of modes of cultural adaptation. There is some suggestion, for example, that land use intensity in the Owyhee Uplands increased after 2000 B.P., at the same time that it decreased in the Steens-TCOCU vicinity.

The TCOCU project has contributed important new ideas and information to the study of the cultural resources of the Oregon-Idaho-Nevada border region. The introduction of new and successful field methods may result in improved standards for and more consistent production of usable data from future survey projects. The addition of the geographic database to the analysis of the project area environment has allowed a more realistic and accurate assessment of the relation between settlement patterning and environmental correlates, as well as provided a new and promising way to predict systematically and in a testable way where concentrations of cultural resources may be found. The geographic database also makes it possible to systematically compare this project area to future project areas in terms of environmental characteristics, a great improvement over impressionistic discussions.

Associated with the database, the correlation analysis of predicted land use intensity and the field data comprises a new, straightforward and effective way to measure the accuracy of our judgments about the prehistoric cultural attractiveness of environmental attributes. It tells us how well our concepts work, and is a stimulus toward improvements in those concepts. The method also helps to clarify mid-range archaeological theory about the connections between environment and land use, in that it forces careful thinking about available data as a reflection of prehistoric behavior. It serves to point out, for example, some of the weaknesses of the site as a measure of prehistoric land use.

Of course, some of the major contributions of this project are in the category of new data, as summarized above. These data already have made possible a valuable reconsideration of regional patterns, and will continue to do so by virtue of comparisons with data yet to be collected by future projects. Of particular note is the discovery that possibly substantial numbers of intact caves and rockshelters still exist in the TCOCU, despite the ravaged character of most such sites previously recorded. This information speaks well for the future of archaeological research in the area, for it means that the abundant data available from open lithic sites can be complemented by the stratigraphic record and expanded artifact inventory of sheltered camp sites. Another result worthy of comment is the clarification of the distributional character of Whitehorse obsidian, which now has been shown to be widespread in the TCOCU rather than present in a single locality or cluster of locations.

The final category of important contributions from this project is that of interpretations of prehistory. Among the variety of interpretations made, a noteworthy one is the revision of the evolutionary model of prehistoric land use originally proposed by Pettigrew (1984). The revised model presented here appears to account well for the available data, and lends itself to predictions testable by future projects. Another interpretive contribution is a new review of regional projectile point chronology. This review, while not exhaustive, brings together information not previously considered in concert, but which must be taken into account by proposed chronologies. Lastly, this project has helped to highlight what may be important differences between the Steens-TCOCU area and the Owyhee Uplands. Though evidence is far from conclusive, indications now are that the late prehistoric period, after 2000 B.P., may have experienced increased occupational intensity in the Owyhee Uplands at the same time as the Steens-TCOCU area was undergoing a diminishment. Patterns such as these are the stuff of which future research designs may be made.

MANAGEMENT OPTIONS AND RESEARCH DIRECTIONS

The results of the present project are useful for a variety of purposes, one of the most important of which is the development of a management plan for cultural resources. For a management plan to succeed, it should be of sufficient scope to handle the magnitude of the resources under the agency's care, and be designed to accommodate the special needs of those resources.

The project area currently is used largely for cattle grazing and for recreation. Mining is prominent in the southern portion. These uses seem unlikely to change in the foreseeable future, though proposals to set aside some land as a wilderness area may raise the relative importance of recreation and attract more non-local users. Present BLM policy, as we understand it, is to manage the land conservatively, maintaining and if possible enhancing its present values, protecting it against deleterious impacts, and at the same time encouraging responsible economic use. At this time, cattle grazing appears to be the most productive economic use of federal land in the TCOCU, though the economics of recreational use may be more difficult to gauge. Without question, those members of the general public most intimately familiar with the area, and with the largest financial stake in its future, are the local ranchers.

Within this context, cultural resources might be viewed by some as of rather little consequence, since they appear to have little economic worth. However, BLM policy is not to rank resources in terms of dollar value, but rather to carry out its mission to preserve all resources under its care, as well as to follow federal procedures, including the body of federal regulations regarding inventory and protection of cultural resources. It is not difficult to demonstrate the considerable scientific importance of archaeological sites. Thus, cultural resources, regardless of opinions regarding their monetary value, are important assets of the land over which the BLM is steward.

Unfortunately, archaeological sites are quite fragile, and may require special attention to assure their survival. Information obtainable from these sites is derived as much from the spatial patterning they contain as from the objects and samples they yield. Thus, disturbance of any kind is a form of destruction. Throughout the country, modern development and relic hunting are the chief threats to the cultural record. In the TCOCU, these threats come mostly in the form of spring developments, site vandalism, and, to some extent, cattle grazing. BLM efforts to minimize these threats might be assisted by an assessment of the resource base in need of protection.

MAGNITUDE AND DISTRIBUTION OF CULTURAL RESOURCES

Because the TCOCU survey sample was selected to be representative, the data can be used to portray both the magnitude and the character of the cultural resources in the study area. The magnitude of the cultural resource base in the TCOCU cannot be calculated accurately simply by multiplying the results by some factor, since the survey quadrats were biased somewhat in favor of resource discovery. Instead, the regression analysis described in Chapter 5 should be applied to project the amount and distribution of cultural manifestations according to the predicted land use intensity (I_7). The regression line formula to predict $\log l_0 PI$ on the basis of I_7 is as follows:

$$\mathrm{Log}_{10}PI = 0.62271(I_7) - 0.51305,$$

and to predict PI itself the relationship becomes exponential:

$$PI = 10^{0.62271(I7) - 0.51305}$$

Similarly, the number of sites (S) is predictable on the basis of the value of I_7 by use of this formula determined by the regression analysis:

$$S = 10^{0.24629(I7) - 0.79621}$$

These formulae must be used with care, and with an understanding of their limitations (among other things, we must keep in mind that land use intensity is not the same thing as the density of cultural debris on the ground, though they are assumed to be closely related), but they serve as the best available predictors for the amount of cultural evidence to expect in any given quadrat. Applying the formulae to each of the 1889 quadrats in the project area, and taking the sums of the expected count of prehistoric items and the expected count of prehistoric sites, we find a predicted 468,576,416 prehistoric items (representing still only 13% of the total present and visible on the surface) and 5,887 prehistoric sites for the project area as a whole. Dropping out the quadrat with the highest I_7 value (14.627) and the highest corresponding predicted counts of prehistoric items (393,849,229) and prehistoric sites (640), the expected totals fall to a more reasonable 74,727,187 prehistoric items and 5,247 sites. These are still very large numbers that seem possibly too high, not only intuitively but also because the regression lines in each case are based to only a limited extent on extremely productive quadrats, and thus may not be steep enough to reflect accurately the relationship between I_7 and the dependant variables at the high end of the scale.

As a comparison, the predictions for the entire project area, assuming that the quantities found are 1.7% (the sampling percentage) of the total, would be 2,549,059 expected prehistoric items and 3,824 sites. Even though the sample was chosen to bias the results in the positive direction, these numbers may be too low, especially with regard to prehistoric items, since most of the items recorded, and many of the sites, were found in a few remarkably productive quadrats. There surely exist quadrats significantly more productive than those found in the survey, and these may inflate the count beyond the predicted numbers.

Thus, the project area as a whole may be expected to contain somewhere between 2,500,000 and 75,000,000 prehistoric items (as visible from survey transects spaced at 30 m intervals) and between 3,800 and 5,200 prehistoric sites (as defined in this report). In terms of mean density by area, these projections are 5,565 PI/mi^2 (2,149 PI/km^2) to 166,939 PI/mi^2 (64,456 PI/km^2), and 8.5 sites/mi^2 (3.27 sites/km^2) to 11.57 sites/mi^2 (4.47 sites/km^2). At the rate of 942 PI per classifiable projectile point discovered by the survey, this means that between 2,600 and 80,000 projectile points are recoverable (using the methods described in this report) from the project area. If rockshelter sites exist throughout the project area in the same proportion as they were found by this survey (6 of 65 prehistoric sites, or 9.23%), then 350 to 480 such sites are possible for the entire project area. This could be an overestimate, of course, if sampling error has inflated the number of rockshelters found by the survey. Even if so, as few as half those projected numbers (175 to 240) still constitutes a substantial population of sites.

The size of the resource base has limited utility, however, without consideration of its distribution. It is apparent from our analysis that, though prehistoric sites and cultural debris are present throughout the project area, they are highly concentrated in a relatively small proportion of that area. As shown in Table 6.1, if the project area is divided into four quartiles (25% of all quadrats in each) on the basis of predicted land use intensity (I_7), it becomes evident that the densities of PI and sites are likely to be low for all but the fourth quartile (with the highest values of I_7), which probably contains the majority of both PI and sites for the project area. Even if the minimum estimate for total PI (about 2,500,000) in the project area is applied, the fourth quartile still would contain more than 98% of all the prehistoric items; if the minimum estimate for sites (3,800) is used, the fourth quartile still would contain 70% or more of the sites in the project area. Using the data in Table 6.1, predicted site densities for the four quartiles are (1) $0.63/\text{mi}^2$ ($0.24/\text{km}^2$), (2) $4.29/\text{mi}^2$ ($1.66/\text{km}^2$), (3) $5.40/\text{mi}^2$ ($1.86/\text{km}^2$), and (4) $36.40/\text{mi}^2$ ($14.05/\text{km}^2$). Even if the minimum predicted number of sites is adopted, the density for the fourth quartile would still be about an order of magnitude greater than the remainder of the project area.

As an aid to agency management of cultural resources in the TCOCU, we have included Figure 6.1 (located in pocket inside back cover), a map of the project area showing the distribution of quadrats classified into four groups (quartiles) on the basis of predicted prehistoric land use intensity (I_7). The patterns shown on this map are not the nicely clustered and bounded areas that one might hope to find on such a chart, because land use intensity was not predicted in a simplistic way, but by means of a complex consideration of a variety of variables. The patchwork arrangement that resulted from this process is likely to be a fair reflection of the truly complex decision-making carried out by prehistoric people in their exploitation of the area. The clearest pattern is that associating the highest-intensity quadrats with the high elevation system of ridges and with low elevation streams. The lowest-intensity quadrats are those on medium slopes without water sources, ridges or rimrock. Because of the complex interplay of the environmental variables, most quadrats fall somewhere in the middle range.

We must emphasize that the generalizations made about the magnitude and distribution of cultural resources in the project area, though they are based on the best data available, are tentative and not conclusive. The predicted land use intensity formula was modified to maximize the value of I_7 for the particular dataset collected by this survey, and thus cannot be tested by use of the same data. Comparison with previously collected datasets from the

Table 6.1. Predicted Ranges of Prehistoric Items and Sites for Project Area Quartiles Arranged by Predicted Land Use Intensity.*

	PREDICTED PREHISTORIC ITEMS			PREDICTED PREHISTORIC SITES		
Quartile Range of I_7	Range per Quadrat	Total for Quartile	%	Range per Quadrat	Total for Quartile	%
-0.300-2.389	0 - 9	1,345	0.0	0 - 1	71	1.4
2.400-2.945	10 - 21	5,837	0.0	1	482	9.2
2.960-4.280	21 - 142	30,984	0.0	1 - 2	606	11.5
4.310-14.627	148 - 38,046,087	74,689,021	99.9	2 - 254	4,088	77.9
Grand Total		74,727,187	100.0		5,247	100.0

* Data on range and total for the highest ranked quadrat (I_7=14.627) have been deleted for this table.

project area was inconclusive because of special difficulties with those datasets. Thus, it would be unwise at present to rely excessively on the results of this project for management purposes.

Among the more important management goals for cultural resources are the protection of the resource base, the prudent use of the resource base for the public good, and the containment of management costs. Realization of these three closely related goals can be enhanced by proper use of data generated from the TCOCU. On the basis of the information now available, it appears that management effort can be most effectively applied in (but should not be exclusive to) that quarter of the project area containing the bulk of the cultural resources. Modern land use will have maximum impact on cultural resources, vandalism of sites will be most intense, data collection for some purposes will be most efficient, and enforcement of cultural resource protection law will be most effective in that portion of the TCOCU. Management expenditures can be held in check by taking these considerations into account. For example, if the protection and perhaps sampling of rockshelters is a desired end, inventory activities might be focused on the zone of highest predicted site density. However, because concentrations of cultural resources inevitably will be found in the remaining 75% of the project area, particularly near sources of lithic raw material (whose locations we thus far are unable to predict), management attention cannot reasonably be limited to a fraction of the project extent.

RESEARCH POTENTIAL

The value of cultural resources lies largely (though not exclusively) in the potential they hold for supporting research. To a great degree, then, their significance is measured in terms of the research issues that they might help to address. As pointed out above, the cultural resource base of the TCOCU is substantial, and systematic management is difficult, often requiring that hard choices be made. A consideration of the research potential of cultural resources in the TCOCU, then, may serve usefully to guide judgments regarding the disposition of archaeological materials and sites.

A persistent research problem area, and one often beset by controversy in the Great Basin, is chronology. A number of issues in this area were discussed in Chapter 5, among them the question of the temporal association of Elko series points, the time of introduction of the bow-and-arrow, and the possibility of two temporally distinct populations of Gatecliff series points. These issues may be of rather slight importance by themselves, but take on special urgency in light of the rather few secure temporal markers on which we have to depend. To address and solve such questions, ways must be found to date sites and temporal markers at least relatively and, it is hoped, objectively (in terms of calendar date).

The TCOCU has the potential to add materially to chronological information, through a number of avenues. First, this research has made it clear that collectible and classifiable projectile points in original surface context are still abundant, making available a reservoir of specimens for temporal as well as for technological and functional study. The relative placement of point types collected from surface contexts can be examined through seriation as well as by means of co-occurrence analysis (Pettigrew 1983). In fact, as discussed in Chapter 5, surface assemblages afford an opportunity to sample smaller slices of time than the usually mixed rockshelter sites, and offer up their data more easily and inexpensively. Objective dating of projectile point types as well as of temporally undiagnostic items (such as flakes) can be realized through obsidian hydration. Though prior determination of obsidian sources (Hughes 1984, 1986) is needed to control for source-specific hydration rates, and association with an independent dating method must precede hydration rate estimation, the method has produced remarkably successful results (Layton 1972, 1985; Pettigrew and Lebow 1987; Tuohy 1980), and shows promise even for surface-collected artifacts (McGonagle 1979). The presence of buried cultural deposits in both alluvial and rockshelter contexts in the TCOCU means that objective radiocarbon dates are obtainable and associable with obsidian hydration rind measurements, and that determination of a local hydration rate simply awaits the proper application of effort. Even without an established rate, some problems, such as the Elko and Gatecliff point chronologies, are addressable by relative means.

The determination of chronology by objective dating of stratified sites seems also to be possible in the TCOCU. As suggested above, sites alongside major streams (such as Willow Creek, well known for its large sites), and rockshelter sites, are abundant in the area, providing ample opportunity to establish stratigraphic sequences to supplement and order the data from surface sites.

Questions concerning human land use patterns are some of the most pressing and interesting available, particularly in light of competing models (Beck 1984; Pettigrew 1984; this volume). Further study of settlement patterns, using additional samples or targeting specific site types or environmental zones, could help to further test the applicability of the available models and to suggest new ideas. Targeted investigations could help to find the elusive winter camp or village sites, or to obtain data on the seasonal round of various periods (using seasonality data from preserved organic debris in buried sites). Other interesting questions include the possible over-hunting of the TCOCU during the fourth millennium B.P., the influence of lithic sources on settlement locations, the nature of early upland occupation in the Transitional Archaic (7000-5000 B.P.), and the causes of reduced land use intensity after 2000 B.P. while intensity apparently increased in the Owyhee Uplands.

In conjunction with distributional analyses, the study of land use patterns requires also the investigation of site function, or the kinds of activities that took place at sites or in definable areas. Since subsurface investigations have not yet been done, it is not certain that analysis of features, which would closely address site function, will be a productive approach (though we suspect it will be). It is clear, however, that the study of lithic assemblages is a worthwhile endeavor, since lithic debris is abundant in the project area. Through study of lithic collections, researchers may infer a wide range of activities, such as the manufacture and repair of various tool classes, lithic reduction stages (Muto 1971, 1976), the working of softer materials (through microwear analysis--see Gendel 1987; Keeley 1974, 1980), maintenance activities involving the use of little-reduced flake tools, raw material procurement, plant processing, separate episodes of occupation (Pettigrew 1983), and even the hunting of particular species (through blood residue analysis--see Loy 1983, 1985, 1987). Variability between sites in terms of lithic assemblage parameters is widely considered to be strongly influenced by behaviors relating to site use (Binford 1980; Elston 1986; Hanes 1988; Lewarch and O'Brien 1981; Pettigrew and Spear 1987; Thomas 1983:419-433). Thus, the TCOCU offers a wealth of data from both surface and subsurface contexts relating to human use of particular sites and areas. By this means, sites may be classified functionally and placed into models of settlement and land use patterns.

Trade patterns constitute an important research area that is addressable primarily through obsidian sourcing (Hughes 1984, 1986). Though most of the obsidian found at sites in the TCOCU appears to be of the Whitehorse type, other types clearly are present, particularly at low elevation sites and among the projectile points. Hanes (1988) has shown that prehistoric people at Dirty Shame Rockshelter made use of a wide variety of obsidian sources from many directions, and that the use of the various sources changed through time, possibly reflecting trade connections or travel routes. Beck (1984) displays similar information for the Steens Mountain area, and Hughes (1986) performs in-depth studies of parts of south-central Oregon and northeastern California. A similar study of obsidian source variation in time and space in the TCOCU would open a new avenue of research there that could connect the locality more firmly to adjacent areas in terms of regional patterns of exchange. Such a study might help us find out what caused the apparent reduction in the use of Whitehorse obsidian and the increased use of cryptocrystalline silica in the TCOCU after 2000 B.P.

A quite important but often ignored arena for investigation is that of methodology. The present project has made use of methods and approaches not commonly utilized in Great Basin research, but which show promise for the future. Chief among these are the geographic database and the creation of a predictive model. We used the geographic database as a means of predicting land use intensity, and it figured prominently in the selection of the survey sample. The database had to be generated manually from existing maps, on which environmental data were limited to standard categories. We are aware that more sophisticated applications of this method, involving the use of computers to select, manipulate and display key environmental data, are possible (LaLande 1985; Smith 1985), and hope that our effort will help stimulate a move in that direction. Now that a geographic database is available for the TCOCU, further archaeological research there can function to test its applicability and possibly to generate ideas about how geographic databases may be used in archaeology and related fields.

Predictive models have become a prime topic of archaeological discussion (Ambler 1984; Berry 1984; Bettinger 1980; Cordell and Green 1984; Lyman 1985b; Pettigrew 1985b; Plog 1984; Tainter 1984), and are used by some federal land-managing agencies despite much concern among archaeologists that unvalidated models are being used to justify Section 106 (1966 Historic Sites Preservation Act) clearance of unsurveyed areas. The essential feature of a predictive model is the proposition of a connection between environmental variables and the locations of archaeological sites, such that the areas where such sites tend to be found can be delimited on maps. There is general professional agreement that connections exist between places of cultural activity and environmental variables, but there is also general acceptance that no model is perfect, and some may be quite unreliable. Anyone can propose a predictive model on the basis of preconceptions, intuition or experience, but without some form of systematic and scientific validation its accuracy and reliability must remain unknown. In the TCOCU project area, we have generated a predictive model on the basis of the present dataset, but the reliability of the model is yet to be measured. Thus, the cultural resources in the project area can be used to validate (or possibly discredit) the model or to revise it to improve the correlation between the predicted land use intensity and the concrete measures of human use (PI counts, site counts, or total site area) within the defined quadrats. Just how high a correlation can be achieved is unclear, but the higher the correlation obtained, the more confident we can be that we truly understand the nature of human land use in the area. Furthermore, the degree of success of this kind achieved in the TCOCU conceivably can be duplicated in other project areas, and thus may serve as a valuable example.

One more methodological area worth mentioning is that of sample size adequacy. The present survey covered only 1.7% of the total project area, and we are generalizing from that sample to the entirety. Despite all efforts at stratifying the population and carefully selecting the sample, we have no real way of demonstrating that the sample is truly representative. Thus, data collected from the TCOCU in the future should and will act as a testing ground for our sampling procedures, but only if the samples chosen in the future themselves are chosen to be representative. As we have already seen, project-specific samples are likely to represent only the loci sampled, not the entire TCOCU project area.

RECOMMENDATIONS FOR FUTURE INVENTORY AND INVESTIGATION

The cultural resource base in the TCOCU is large, but nevertheless finite and inevitably diminishing with each passing year. Attrition results mostly from vandalism (unauthorized excavation and artifact collecting from the surface), and impacts from modern land uses. Management of these resources, then, should involve an effort to minimize the rate of attrition and to foster their proper use. This effort should involve more than simply inventory and avoidance of cultural resource sites, but play an active role in improving our understanding of the cultural patterns reflected in the data. Active research is an important part of management because the value of the resource lies in its information content, not in the mere existence of ancient artifacts. The greater our knowledge of the past societies responsible for the cultural debris, the more informed can be modern management of the resource base. To know how rare or plentiful sites of a particular type are, for example, we must first find out how many of them exist. To know how significant they are, we must first make a real attempt to discover how much we can learn from them. Some sites will need to be salvaged prior to unavoidable impacts of development or other activities; data from such sites can be most effective when placed into an existing and experienced research design. It should be evident, then, that the managing agency should play an active role in the investigation of its cultural resources to assure an informed management policy and to guarantee that research conducted using data from its holdings is conducted in the most effective way.

It is with such thoughts in mind that the following recommendations were conceived. Some recommendations are more strictly related to management, while others fall closer to the realm of research, but all are suggested to further the stewardship goals of the BLM in the context of what we have learned from this study of the TCOCU.

1. As the purveyors of the predictive model for the project area, we feel particularly obliged to reiterate that the model remains unvalidated, and should be tested before it is accepted as the final word about cultural resource distribution. The best form of validation would be a survey similar to that described here, with a carefully selected sample designed to represent the project area and totally independent of the sample already surveyed. Specific expectations, in terms of a wide variety of cultural evidence, of any such sample can be generated on the basis of information presented in this report, and compared with the results of the survey to measure the accuracy of the predictions, and thereby the reliability of the model as it is presently composed. Such additional data, assuming they do not invalidate the

model, can be used also to adjust or otherwise improve the predictive formula, further raising the level of confidence in its generalizations. Additional data may also reveal evidence of site types not presently recorded because of their relative scarcity, but which may have unique values, and may expose patterns of distribution for the lithic raw material sources whose locations thus far are not generally predictable. Any clarification of cultural resource distributions would tend to improve the BLM's management capabilities.

2. We assume that inventory of the resource base is an important management goal. If a large increase in the number of inventoried sites is a desired end, surveys should focus on the quadrats with the highest values of predicted land use intensity (I_7), especially those in the top 25% (fourth quartile) of I_7 values. Site densities here appear to be an order of magnitude greater than the average for the remainder of the project area.

3. Special management attention is needed for rockshelter sites, which are particularly subject to vandalism. This project presents evidence that undefiled rockshelters exist in surprisingly substantial numbers in the TCOCU, but such a favorable circumstance may not last long if the existing rate of site destruction persists. Inventory of these sites can be facilitated by focusing survey attention on the fourth quartile areas, where five of the six rockshelters were discovered. A particularly efficient method may be helicopter reconnaissance of rimrock bases in such areas, followed by ground inspection to confirm the presence of cultural evidence.

4. One form of patterning not obtainable by survey of scattered quadrats is horizontal patterning of cultural evidence in localities larger than the quadrat but much smaller than the total project area. Survey of block areas (possibly several contiguous sections) in certain key locales would highlight local patterning not visible in the existing data, and may help further to elucidate the environmental determinants of cultural resource location. Such study of patterning within small areas would tend to improve the predictability of specific site location, since it would shed light on the details of prehistoric choices regarding activity placement in or near resource areas.

5. In future surveys it would be advantageous to use stricter criteria for recording debitage characteristics. We discovered that debitage information (as estimates, not exact measures) can be recorded profitably in the field, but were hampered by our own limited set of criteria and some inconsistencies between survey teams. This situation can be improved by clarifying for survey teams the precise measures and forms of debitage data to collect.

6. To complement the mostly upland data from the TCOCU, make possible a more complete picture of changing prehistoric settlement patterns and land use, and facilitate cultural resource management of the extensive and possibly even more threatened tracts of BLM land at lower elevations, surveys similar in design to that described here should be undertaken in lowland project areas. A good prospect for such study near the TCOCU would be the Coyote Lake lowlands, where evidence of WPLT (11,000-7,000 B.P.) occupation appears to be plentiful (Butler 1970; Southard 1969). Such an area may contain the winter

camps or villages that were home to many of the prehistoric people who used the TCOCU. Lowland data would supplement what has already been collected from BLM land in the Alvord Basin (Pettigrew 1975, 1984), and would create a total upland-lowland dataset by which to address the full range of questions regarding settlement patterns.

7. As part of its ongoing effort to learn more about its resource base, the BLM should plan to undertake surveys of this kind in other parts of its territory, to clarify patterns in local areas as well as develop a better regional understanding of the nature and causes of settlement pattern variability. Such information would serve to further improve the comprehension of local cultural resource distributions by creating a refined explanatory context.

8. Since the majority of cultural resources in the TCOCU, and very likely elsewhere on BLM holdings, are found in lithic scatter sites, we recommend that a management program or set of standards be drawn up for their disposition where data collection is made necessary by threatened or ongoing impacts. Such standards should include systematic surface collection designed to record horizontal patterns, testing to assure that no subsurface deposits exist, and a prescribed battery of analyses devised to maximize the research results. Some experimentation with analysis is desirable to find ways to extract information from such data. Development of the standards should draw upon previous research conducted and reported throughout the world, not simply on work done thus far in the Pacific Northwest or the Great Basin.

9. Vandalism of sites, especially by unauthorized excavation, is a key management problem on BLM land in the TCOCU as well as other areas. Such vandalism most often is directed at buried sites with high densities of cultural debris, particularly rockshelters and dense streamside sites. Destruction of cultural resources by this process might be slowed by enforcement and education efforts, but is unlikely to be eliminated. Thus, one side of management of these fragile resources should be to recover some threatened data before they are forever lost. With regard to rockshelter sites, which on the basis of past experience appear particularly threatened, the BLM should carry out a policy of data recovery, not simply from sites that have been badly vandalized, but also from pristine sites that may soon be discovered by vandals. We recommend that, at each rockshelter site where data recovery is undertaken, sampling should be complete (i.e., include all of the cultural deposits), not fractional, since archaeological excavation of a site inevitably will call attention to it, and remaining intact deposits most likely will be destroyed. Excavation and analysis should be carried out with the highest professional standards, to maximize research results, since data recovery can be accomplished only once.

10. With regard to open sites in alluvial settings, where dense cultural deposits attract vandalism, complete data recovery as a form of salvage or mitigation would be impractical. Instead, the particular locations usually targeted by vandals at such sites (generally the areas of highest density of cultural debris or features), should be substantially sampled in cases where the site seems especially threatened. As with rockshelters, in some cases it may not be wise to wait until vandalism has taken place, but instead to

undertake preemptive data recovery. As with rockshelters, the highest professional standards should apply to this work. Since stratified alluvial sites potentially offer the best means of addressing issues of chronology, sampling there should be designed to generate the most effective data for that purpose.

11. Analysis of data from all cultural resource projects should include obsidian studies, both obsidian sourcing and hydration. These studies are relatively inexpensive, and are likely to lead to a remarkable level of temporal control for prehistoric data. As pointed out previously, obsidian sourcing should contribute data useful for interpreting patterns of exchange, and is needed to control for hydration rate variability by source. Obsidian hydration rind measurements can be associated with the age of specimens, either relatively or objectively, for both buried and surface artifacts, and for flakes as well as projectile points. It is a method that can be used to associate items found at separate locations in the absence of other data, and is particularly well suited to places like the TCOCU where obsidian is plentiful and dominated by one major chemical type. Development of an obsidian hydration rate for Whitehorse obsidian should be an important priority for the area, to facilitate assessment of sites for management or research purposes.

12. This project illustrates the substantial value of a geographic database for environmental assessment and other archaeological purposes. We believe that geographic databases should be used more commonly, and recommend that the BLM investigate how computerized geographic information systems (GIS) may be used for management of archaeological and other resources. Armed with powerful information-processing tools, researchers and managers could accomplish even more complex environmental analyses than those done for this project, and with less effort.

13. Prediction of cultural resource concentrations could be enhanced significantly if we could predict the locations of toolstone sources. The BLM should consult with geological experts to explore this problem, to see if some measure of such prediction can be accomplished.

14. Although cattle have some effect on the integrity of archaeological sites, in general this is much less serious than other forms of attrition, particularly vandalism. Two site types appear, however, to sustain more damage from cattle than others: spring sites and rockshelters. Concentrated water sources like springs attract cattle and focus their impacts, and developments that concentrate water exacerbate this situation. As much as possible, spring developments near archaeological sites should be designed to attract the cattle away from the cultural deposits.

Rockshelters, as we have been able to determine from inspection, are used as refuges by cattle. We suspect that cattle, in sites were perishables exist on or near the surface, at times seriously damage some of the perishable cultural debris. Additionally, the soft deposits in such sites might be disturbed more easily and more deeply than the harder soils present elsewhere. For these reasons, the BLM should investigate the extent of cattle damage to rockshelters, and if warranted fence or otherwise block the entrances.

15. Enforcement of laws is one important means of safeguarding cultural resources. Enforcement may be more easily accomplished in the TCOCU than in some other places because of the natural difficulty of access to the area. The BLM should investigate ways of taking advantage of this situation, such as by monitoring traffic or through cooperation with local ranchers, to keep tabs on potential violators. Also simplifying enforcement somewhat is the determination that most of the cultural resources are present on a fraction of the land. The high-intensity areas tend to be those with roads (largely ridges at higher elevations and along streams in the lowlands). Monitoring and spot-checking thus can be focused in the predicted high-intensity areas with considerable savings of effort.

It also occurs to us that particularly threatened rockshelters might be protected electronically, by monitoring devices. Installed inside the shelters and associated with clearly visible signs, such devices, possibly including cameras, might discourage potential looters. Of course, some way would have to be found to assure that cattle could not trigger false alarms. We are not closely familiar with the technical difficulties of such an enterprise, but believe that consideration of such methods might lead to the development of a workable program.

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APPENDIX A

DESCRIPTIONS OF INDIVIDUAL SURVEYED QUADRATS

For the purposes of the following presentation, low slopes are those less than 30%, medium slopes are 30 to 59%, and steep slopes are those 60% and over. Major ridges are continuous ridges at least two miles long, while minor ridges are those less than two miles long. For ease in comparison with the results of the survey, the quadrats are presented here in the same order as the data summary (Table 7).

QUADRAT	ELEV. RANGE	WATER	TOPOGRAPHY	SOIL	VEGETATION
40-38-21-NE	7480 to 7680 feet.	No permanent water source was observed.	A broad, minor ridge in the south half of the unit slopes gently (low slope) to an intermittent drainage in the northwestern corner of this 80 acre unit. Aspect is largely northwest, with some southeast-facing slopes present. No rimrock is present, and few rock outcrops.	The soils are semi-deflated silty loams.	The vegetation is chiefly low sagebrush, with low grasses present; the vegetation is dense in the western half of the quadrat.
39-40-27-NE	6860 to 7480 feet.	Cottonwood Creek runs through the unit; a small, but permanent, creek joins Cottonwood Creek within the unit. Three springs were also observed, all near the creeks.	This is a topographically diverse 160 acre quadrat, with a large, relatively flat bench in the southwest quarter, steep slopes into the creeks, and medium slopes in the remainder of the area. A knob marks the northeastern corner. Frequent (almost to the point of being rimrock) rock outcrops are situated along the break between the flat bench and the western steep slopes into the creek; rock outcrops are also present on the eastern slopes. The majority of the aspect is western, although eastern aspect is also common.	The soil is a silty loam, with talus and gravel common on the steeper slopes. Natural obsidian nodules were observed in the gravels of Cottonwood Creek.	The vegetation is primarily medium sagebrush (relatively dense), with thickets of small quaking aspen present on the bench, and tall quaking aspen present along both the creeks.
39-40-5-SE	5720 to 6770 feet	Cottonwood Creek flows through the southwest corner of the unit, and an unnamed tributary to Whitehorse Creek flows along the northern edge of the quadrat.	The landforms in this 160 acre quadrat are dominated by extremely steep slopes, with the exception of a narrow, minor ridge which terminates in the center of the unit, and a small area adjacent to Cottonwood Creek. Rimrock, often in multiple rows, is prevalent on the slopes. Southwestern and northern aspects are present within the unit.	A deflated, gravelly surface is present on the ridge; gravels and talus dominate the slopes. Small (1-2 cm) obsidian nodules are scattered throughout the unit, with the highest density on the ridge.	Vegetation is relatively sparse, but where present is principally low sagebrush and grass.
39-39-22-NE	5790 to 6200 feet.	Fifteenmile Creek flows through the southeast corner of the unit, although there was no water in the creek at the time of the survey. A spring is in the bottom of a draw running through the center of the unit.	This is a topographically diverse quadrat. The eastern quarter of this 160 acre unit is on a large, flat ridge, while a small, narrow ridge is present in the western portion of the unit. In addition to Fifteenmile Creek, two intermittent drainages join and cut through the center of the quadrat. The slopes between the drainage bottoms and ridge tops range from medium to steep. Rimrock is prevalent within the unit. Aspect is variable, but essentially is south and west.	The soils range from deflated gravel or bedrock surfaces on the ridge tops to alluvial silts adjacent to the creek; the slopes are mostly gravel and talus. Small (1-3 cm) obsidian nodules are common, particularly in the eastern half of the unit.	Low sagebrush and grasses predominate on the ridges and slopes, with willow and tall sagebrush found along Fifteenmile Creek.
39-39-13-SW	6180 to 6620 feet.	Doolittle Creek cuts through both the southeast and northeast corners of the quadrat; Dry Creek joins Doolittle Creek just outside the unit.	This 160 acre quadrat is dominated by a broad, flat ridge occupying the western half of the unit. The ground, from the center of the unit eastward, slopes down with medium to low slopes, terminating at tall, continuous rimrock, which runs north-south through the unit. Below the rimrock, steep slopes drop towards the creek. Aspect is predominantly north and east.	Deflated to semi-deflated silty-loam and gravel is on the ridge and on top of the rimrock, with silty loam, gravel, or talus present on the slopes.	Low sagebrush and grass are predominant on the ridge, with taller sagebrush on the slopes. Small patches of quaking aspen and mountain mahogany are present on the steep slope below the rimrock, with patches of willow along Doolittle Creek.

QUADRAT	ELEV. RANGE	WATER	TOPOGRAPHY	SOIL	VEGETATION
38-39-23-SE	5960 to 6270 feet.	No permanent water source observed in the quadrat.	Located in the Fish Creek Breaks, this 160 acre quadrat lives up to the name "Breaks," with five approximately parallel intermittent drainages and four parallel ridges dissecting the unit. Three of the ridges are small and narrow, while the fourth ridge is a major ridge. Rimrock marks the edge of each of the ridges, and steep, but relatively short, slopes drop into the bottom of the drainages. Aspect is variable, and includes northwest, southeast, and northeast slopes.	Deflated gravel surfaces are present on the ridge tops, with silty loam, gravel, or talus present on the slopes.	Low sagebrush and grasses are the chief types of vegetation.
40-38-1-NE	5960 to 6380 feet.	No permanent water sources noted within the quadrat.	The majority of this 160 acre quadrat is situated on a large, flat, major ridge which runs north-south through the unit. Both the eastern and western edges of the ridge is marked by rimrock, below which is medium to steep slopes into intermittent drainages. Only one intermittent drainage is situated within the unit, crossing through the southwest corner of the quadrat. Aspect varies from west and east on the slopes, and north on the ridge.	A deflated gravel surface is present on the ridge, with silty loam, gravel, or talus on the slopes.	Low sagebrush and grasses predominate throughout the unit, with the vegetation very sparse on the ridge. Of special interest was a single juniper, noted on the sheltered eastern slope, below the rimrock.
39-39-9-SW	5700 to 5900 feet.	No permanent water sources were observed.	This 160 acre quadrat is largely flat with low, gentle slopes; two minor, intermittent drainages pass through the southwest corner of the unit. No rimrock is present, and the aspect is west to southwest.	The soils are deflated gravels to semi-deflated gravelly silty loams.	Low sagebrush and grasses predominate throughout the unit.
39-39-5-SW	5110 to 5285 feet.	No permanent water sources were noted.	The only flat ground in this 160 acre quadrat is on a very small ridge (almost a knoll), which was marked by a short stretch of rimrock on the western edge. The remainder of the unit has low, gentle slopes, with three minor intermittent drainages dissecting the quadrat. Aspect includes east, west, and north-facing slopes.	The soils are primarily semi-deflated gravelly silty loams.	Low sagebrush and grasses are predominant, with rabbitbrush very common along portions of the drainages.
39-39-5-NW	5030 to 5222 feet.	No permanent water sources were observed.	The western edge of this 160 acre quadrat is marked by a narrow, minor ridge, with a low slope into two minor, intermittent drainages, and then a gentle rise to a second, low, rolling ridge, dropping off again into a third minor drainage. No rimrock is present. Aspect ranged from east, to north, to west.	The soils are principally semi-deflated gravelly silty loams.	Low sagebrush and grasses are dominant.
39-38-24-NE	5400 to 5790 feet.	No permanent water source was observed in this quadrat.	The dominant landform in this 160 acre quadrat is a broad, flat ridge running north-south through the unit, with a secondary, minor ridge also present in the northeast corner. East of the major ridge and south of the minor ridge is rimrock, below which are steep slopes. West of the major ridge are medium slopes into an intermittent drainage; although rock outcrops are present on this slope, the only rimrock is a small section in the northwest corner of the quadrat. Western and eastern slopes predominate, with the major ridge facing north.	The ridges have a deflated gravelly surface, with gravel or talus present on the slopes.	Sparse low sagebrush and grass is present on the ridges, with thicker and taller sagebrush and grass present on the slopes.

QUADRAT	ELEV. RANGE	WATER	TOPOGRAPHY	SOIL	VEGETATION
38-38-15-SW	4580 to 4780 feet.	No permanent water sources were observed in the quadrat.	This 120 acre quadrat is on a low, west-facing slope, with a minor drainage through the unit. Little topographic relief is provided by the drainage. The southwest corner of the unit has a medium, north-facing slope. No rimrock is in the unit, although the north-facing slope does have rock outcrops.	The soil is a semi-deflated gravelly silty loam.	Sagebrush, rabbit-brush, and grasses predominate (all medium height).
38-38-35-NW	4800 to 4960 feet.	No permanent water sources were noted.	This 160 acre quadrat is almost flat, and has relatively little topographic relief. Aspect is generally northwest. No rimrock was observed.	The soil is a semi-deflated gravelly silty loam.	Sagebrush, rabbit-brush, and grasses are predominant.
38-38-27-SE	4680 to 4760 feet.	Willow Creek, one of the largest creeks in the project area, runs diagonally through the quadrat.	This 160 acre quadrat is relatively flat, with little topographic relief provided even by the creek. A large bench occupies the south-west corner of the unit, rising 5-15 m above the creek. No rimrock is situated within the unit. Aspect is northeast or southwest.	Semi-deflated to deflated gravelly silty loam are present away from the creek, with alluvially deposited silts near the creek.	Willow and tall sagebrush dominate along the creek, while low sagebrush and grasses are more common away from the creek.
40-40-12-NE	7400 to 7840 feet.	No permanent water sources were observed; a spring is shown on the USGS map, but was not present on the ground.	Topographically, this 120 acre quadrat is dominated by a broad, flat, major ridge, running in an east-west direction. A secondary, minor ridge heads north off the major ridge; two canyons, with intermittent drainages and medium slopes, are located east and west of this secondary ridge. The southern edge of the unit (south of the major ridge) is marked by tall rimrock and steep slopes. Aspect varies between west, northeast, and south.	Ridges have deflated gravel surfaces, while slopes have silty loams, gravels, or talus. Obsidian, in cobbles up to 15 cm, is prevalent on the ridge, with lesser densities elsewhere.	On the ridges, vegetation is sparse, consisting of low sagebrush, rabbitbrush, and grasses. Vegetation on the slopes was similar, but was thicker and taller.
38-40-11-NW	5850 to 6940 feet.	No permanent water source was observed.	The western edge this 120 acre quadrat is situated on the eastern edge of a major, broad, flat ridge; the eastern edge of this ridge is marked by tall rimrock. Below the rimrock is a steep slope down to more rimrock, approximately 200 feet below the upper rimrock. East of this are more steep slopes, with frequent rock outcrops. Three east-flowing drainages deeply incise the unit below the lower rimrock. All slopes are east-facing.	The top of the ridge has a deflated gravel surface, while the slopes are gravelly silty loam, gravel, or talus. Natural obsidian (in nodules up to 20 cm in diameter) is frequent, east from the top of the lower rimrock, for about 450 m.	Sagebrush and grasses are the primary vegetation, with mountain mahogany present on top of the ridge and between the two levels of rimrock. Vegetation is relatively sparse throughout the unit.
38-40-19-NW	6260 to 6500 feet.	No permanent water source was noted.	This 160 acre quadrat, situated on a large, major ridge, is relatively flat, with small draws and ridges providing slight topographic relief. The exception is the northeast corner, where rimrock marked steep slopes. The aspect is variable, but is generally northwest.	Soils range from deflated gravel surfaces to semi-deflated gravelly silty loams. Natural obsidian is prevalent in the unit, with highest densities in the northeast corner, along the northern edge, and in the southwest corner.	Although sparse, low sagebrush and grasses are the principal plants, with a few mountain mahogany present.
38-40-20-SW	6360 to 6800 feet.	No permanent water source was observed.	This 160 acre quadrat has diverse topography. A major, but relatively narrow, ridge runs generally north-south through the unit; east of the ridge is a medium to low slope, terminating at the northeast corner with rimrock, and steep slopes. West of the ridge is a low slope to the edge of the unit; low north-south trending rimrock traverses this slope.	Soils in this quadrat are semi-deflated gravelly silty loams and deflated gravel surfaces. Naturally occurring obsidian nodules are found along the western edge of the quadrat.	Sagebrush and grasses are predominant, with occasional mountain mahogany present. Density of vegetation was variable.

QUADRAT	ELEV. RANGE	WATER	TOPOGRAPHY	SOIL	VEGETATION
38-40-14-SE	5310 to 5425 feet.	No permanent water source was noted.	This 40 acre quadrat is situated on an east-facing, constant, low slope, with little topographic relief. A single minor intermittent drainage cuts through the quadrat, but provides little elevation difference. No rimrock is present within the unit.	The soil consists of slightly deflated, colluvially deposited silty loams. Small obsidian nodules were occasionally observed.	Fairly dense, medium high sagebrush was common, with bunchgrass and other grasses present.
38-40-1-NW	5100 to 5330 feet.	No permanent water source was observed.	This 160 acre quadrat is topographically similar to the previous unit, with a low, fairly constant, eastern facing slope. Five drainages dissect the unit, but they provide little topographic relief. No rimrock is present in the unit.	The soil is a colluvially deposited silty loam, with low to medium deflation.	As with the previous unit, medium high sagebrush was predominant, with bunchgrass and other grasses present.
39-41-21-NE	5205 to 5680 feet.	No permanent water source was observed.	This 160 acre unit is on low to medium, east-facing slopes. Three intermittent drainages deeply dissect the unit, creating steep slopes into the bottom of the drainages. No rimrock is present, although rock outcrops are frequent.	The soil on the low slopes ranges from slightly deflated to deflated gravelly silty loam; the steep slopes are gravel or talus.	Medium high sagebrush and low grasses dominate.
37-37-13-SW	5285 to 5980 feet.	Little Antelope Creek flows through the southwest quarter of the unit; two springs were also observed, both located on a major ridge.	This 160 acre quadrat is topographically diverse, with very rugged and broken terrain. The majority of the unit consists of steep slopes into either Little Antelope Creek, or one of the two intermittent drainages in the unit (one of which joins Little Antelope Creek within the unit). A wide, major ridge runs east-west through the northern third of the quadrat, while a rock knob and a saddle are located in the southeast corner. Rimrock is extensive, marking the upper limits of the steep slopes, and is found in two levels in a portion of the break between the major ridge and the steep slopes. Aspect is variable, with northern and southwestern most common.	The slopes consist of gravel or talus, while the major ridge ranges between extremely deflated gravels, and bedrock. Alluvially deposited silts can be found adjacent to the creek.	The major ridge was virtually scabland, with little vegetation. The slopes had mostly medium high sagebrush, while the riparian vegetation included tall sagebrush, quaking aspen, and willow. It is interesting to note that a single pine tree was observed near the creek, just southeast of the quadrat.
37-37-14-SE	5250 to 5800 feet.	Little Antelope Creek flows through the entire quadrat.	Steep slopes into Little Antelope Creek dominate the terrain in this 160 acre unit (although the slopes become medium to low on the northern side of and near the creek). A major ridge cuts across the northeast corner, but the ridge is very narrow at this point. A broad, flat, but minor, ridge runs through the southern half; south of this ridge, in the southwest corner of the unit, is an intermittent drainage. Rimrock is extensive, and is found along the edges of both major and minor ridges. Aspect is largely north and south.	The ridges are either bedrock or very deflated gravels, while the steep slopes are gravel or talus. Alluvial deposits can be found adjacent to the creek. Extensive deposits of natural CCS are present on the minor ridge.	The slopes are essentially medium high sagebrush and low grasses, while sparse, low sage-brush is found on the ridges. The riparian vegetation is chiefly tall sagebrush, with some willow present.
39-41-36-SE	4800 to 4860 feet.	No permanent water source was observed within the quadrat.	This 40 acre quadrat is situated on a low (almost flat), constant, east-facing slope. Numerous shallow intermittent drainages dissect the unit, but provide little topographic relief. No rimrock is present in the unit.	The soil present in the unit is a colluvially deposited silty loam (not deflated).	The vegetation is predominantly grass, with medium high sagebrush common.
39-41-11-SW	4820 to 4910 feet.	No permanent water source was observed within the unit.	This 160 acre quadrat is located on a low (almost flat), east-facing, constant slope. Six small, shallow drainages are present in the unit, but they provide little topographic relief. No rimrock is present in the unit.	The soil consists of colluvially deposited gravelly silty loam, which was slightly deflated.	Medium high sagebrush is the main vegetation.

QUADRAT	ELEV. RANGE	WATER	TOPOGRAPHY	SOIL	VEGETATION
40-41-7-NE	7120 to 7820 feet.	Several springs and seeps were observed on the steep slopes in the southwest corner of the quadrat.	The dominate landform in this 120 acre quadrat is a broad, flat, major ridge running east-west. North of this ridge, low slopes lead into the heads of two canyons. The south edge of the ridge is marked by tall rimrock, below which are very steep slopes. These slopes are deeply dissected by three intermittent drainages. A knob is situated in the center of the unit. Aspect is generally north and south.	The surface of the ridge is deflated gravels, while the low slopes have moderately deflated gravely silty loams, and steep slopes are gravels and talus. Small obsidian nodules were seen on the ridge.	Sparse, low sagebrush is the primary vegetation on the ridge, while taller and more dense sagebrush, rabbitbrush, and grasses are present on the slopes.
40-41-19-SE	5960 to 6530 feet.	No permanent water source was observed within the quadrat.	This 120 acre unit is half on a broad, flat, but minor, north-south trending ridge; the remaining half is on medium, south and southwest aspect slopes. The break between the ridge and the slope is marked by tall rimrock. A fairly large draw cuts through the slope.	Soils range from widespread deflated gravel pavement to bedrock on the ridge, and gravel and talus on the slopes.	The vegetation was sparse throughout the quadrat, with low sagebrush and grasses predominate.
40-39-14-SE	5800 to 6400 feet.	Payne Creek flows through the length of the quadrat; several seeps and springs are located adjacent to the creek in the southeast corner.	Virtually all of this 160 acre unit is situated on medium to steep slopes; the only exceptions are low slopes adjacent to Payne Creek, and low slopes on a narrow, minor ridge that runs generally north-south through the unit. Rock outcrops are common on the steep slopes above Payne Creek, but are not quite frequent enough to be called rimrock. Aspect is generally east and west.	The steep slopes are gravel and talus, while the medium slopes are generally semi-deflated gravelly silty loams, and the ridge is deflated gravels. Alluvial silts are present near the creek. Occasional small obsidian nodules were seen.	Low sagebrush and grasses were the principal vegetation.
41-39-18-SW	6160 to 6580 feet.	Three springs were observed within the unit.	The slopes in this 160 acre unit were mostly low, with medium slopes in the western quarter of the quadrat. A broad, flat, minor ridge/saddle is located in the northeast corner of the unit, while a broad, shallow draw is in the southeast corner. Numerous small, shallow intermittent drainages cut through the unit, creating quite broken terrain. No rimrock is present, although rock outcrops are common. Aspect is generally east.	The soils range from completely deflated gravels on the ridge and other flat areas to semi-deflated gravelly silty loam.	Vegetation was mostly sagebrush and grass, with the density and height low on the exposed ridge, and taller and denser in the protected drainages.
41-40-11-SW	5400 to 5720 feet.	No permanent water sources were observed in the unit.	This 160 acre quadrat is located on a generally south facing slope, which ranges in steepness from low to medium. The northeast corner of the unit encompasses the southern edge of a large bench, and thus has the lowest slope. The quadrat is fairly deeply dissected by four intermittent drainages. No rimrock is present, although small rock outcrops were observed.	The soils in this unit are deflated gravels and semi-deflated gravelly silty loam. Talus slopes are present.	The vegetation is mainly low sagebrush and grasses.
41-41-1-SW	5300 to 5840 feet.	A single spring is located in the southwest quarter of the quadrat.	This 160 acre unit is topograph-ically diverse, with slopes ranging from low to steep. A major intermittent drainage cuts through the northeast quarter of the unit; the slopes into this drainage are steep, with numerous rock outcrops. A second, smaller, intermittent drainage joins the larger drainage within the unit. The southern edge of the quadrat crosses two knobs, with a saddle between, while the western boundary is partially on a ridge, and on the side of a knob. The slopes from these knobs and ridges are low to medium. Aspect is variable, and includes east, north, and south.	Soils range from deflated gravels to semi-deflated gravelly silty loams on the low and medium slopes, with gravel and talus on the steep slopes.	The vegetation is generally low sagebrush and grasses, although the sagebrush in the major intermittent drainage is tall.

QUADRAT	ELEV. RANGE	WATER	TOPOGRAPHY	SOIL	VEGETATION
40-40-21-NW	5690 to 6341 feet.	A spring is situated just north of the unit boundary, but no permanent water source was observed within the unit.	The western and eastern quadrat boundaries of this 160 acre unit are both located on north-south ridges; the eastern ridge is a major ridge, although not particularly wide or flat, while the western ridge is a narrow, minor ridge. The slopes from both of these ridges are steep, dropping into a major intermittent creek. A lesser intermittent drainage joins the major drainage within the unit. No rimrock is present, although large rock outcrops are so frequent that it might be considered rimrock. Aspect is generally east and west.	The soil on the ridges is deflated gravel pavement and bedrock, while the slopes are gravel and talus. A single obsidian nodule was observed in the alluvial gravels.	Low sagebrush and grasses are the essential vegetation types.
41-39-12-SE	5280 to 5380 feet.	No permanent water sources were observed in the quadrat.	This 160 acre quadrat has very low slope, with a broad, flat, major ridge running diagonally through the unit. Two minor intermittent drainages also run through the unit. No rimrock or rock outcrops are present; aspect is generally southeast, with slopes into the drainages facing northeast and southwest.	The soils range from deflated gravel pavements to semi-deflated gravelly silty loams. Naturally occurring obsidian nodules were observed, with the highest densities found just south-west of the two intermittent drainages.	The vegetation is chiefly low to medium sagebrush and rabbitbrush, with low grasses common.
41-39-5-SE	5800 to 5920 feet.	No permanent water source was observed within the quadrat.	This 40 acre quadrat is, for the most part, situated on a large, flat bench, with a knoll just outside the southwest corner of the unit, and a draw between the knoll and the bench. No rimrock is present within the unit.	The soil on the bench is a deflated gravel pavement, which is semi-deflated elsewhere.	Low sagebrush and grasses are the primary types of vegetation
40-40-25-SE	5400 to 5640 feet.	Indian Creek runs through the center of the quadrat, but had no water at the time of the survey.	A broad, flat, major ridge runs along the eastern quarter of this 160 acre quadrat; Indian Creek parallels the ridge, but in the western third of the quadrat. The western boundary of the unit runs down a minor, flat ridge. Slopes throughout the unit are low. No rimrock or rock outcrops are present. The aspect ranges from south, to west, to east.	The soils are semi-deflated to deflated gravelly silty loams. This unit had an incredible amount of naturally occurring CCS (including petrified wood), particularly along the major ridge.	The vegetation is mainly low to medium high sagebrush, rabbit-brush, and grasses.
41-41-20-NW	4850 to 5120 feet.	McDermitt Creek meanders through the center of the quadrat.	The landform of this 40 acre quadrat is dominated by the presence of McDermitt Creek, which has relatively large alluvial terraces present on both sides. The slopes away from the terraces are steep. Rock outcrops are frequent. Two minor intermittent drainages join McDermitt Creek within the quadrat. The aspect was largely north and south.	The soils are quite varied, with talus covering the steep slopes, and alluvially deposited silts present on the terraces.	Little vegetation is present on the steep talus slopes; the alluvial terraces have medium to tall sagebrush, grass, and thickets of willow.

APPENDIX B

QUADRAT MAPS WITH SITES AND CULTURAL DEBRIS

The following appendix contains maps of the individual quadrats surveyed by IRI within the TCOCU project area, showing the location of documented archaeological sites and the quantities of cultural debris observed throughout the quadrats. Several notes are necessary to aid in the interpretation of these maps. The numbers on the maps indicate the number of lithic items observed within 30 m increment per transect. However, due to the density of lithic debitage within some sites, it was impossible to include the actual quantities observed in the sites on the maps. Instead, the quantities of lithic debitage within sites are represented by isopleths of 10, 50, 100, and 1000 items/m^2.

These quadrat maps are enlarged from 7.5 minute series USGS maps, to a scale of 5 mm equals 30 m. The information contained on the USGS maps has not been removed. In a few cases, quantities of cultural debris are indicated inside the quadrat boundaries; this represents the actual field survey. The survey quadrats are designated by a label using the township, range, section, and quarter section, such that 37-38-14-SE is the SE¼ of Sec. 14, T37S, R38E. All the quadrats are in the Willamette Meridian. North is at the top of the page on each map. The quadrat maps are presented here in the same order as they are discussed in Table 7 and Appendix A.

KEY

(-10-) = Archaeological site boundary.

--50-- = Isopleth indicating lithic density within sites.

◌ = Rock feature.

▨ = Rockshelter.

◌ = Approximate site boundary outside the survey quadrat.

(sl) = A site located outside the survey quadrat (not recorded).

□ = Location of projectile point(s) collected from within a site.

△ = Location of isolated and collected projectile point(s).

APPENDIX C

PROJECTILE POINT TYPE DEFINITIONS

The following definitions of projectile point types are taken directly from Pettigrew's (1985a) report on research at Lake Abert in the northern Great Basin, as these definitions apply to the points from the TCOCU project. The types are intended to be used as temporal types, and thus the defining attributes are those demonstrated to be chronologically sensitive. The temporal significance of the types is discussed in detail in the text of this report, and will not be presented here. Complete projectile point data, including attribute measurements, are included in Appendix D.

A variety of attributes is used to discriminate between projectile point types, with neck width (NW) one of the most useful and important, used and measured as defined by Corliss (1972). In a large population, neck width will normally appear bimodal, with NW of 8 mm and below representing smaller and lighter points than the broad-necked types (above 8 mm). Occasionally small points have broad necks, and vice versa, so base width (BW) and weight (WT) are used as additional criteria, to separate robust points (BW greater than or equal to 10 mm, WT greater than or equal to 1.65 g) from the narrow-necked group, and to place them with the broad-necked specimens.

Other attributes used to discriminate types of projectile points are as follows. Stemmed points are those with distinct notches or shoulders, defining a hafting element separate from the blade. Side-notched points are those with notches whose axes are approximately perpendicular to the long axis of the point. Lanceolate points have blades whose lateral edges are convex and, at least at one location, parallel to the long axis of the point. Triangular points have blades whose lateral edges are generally straight, diverging from the point tip, and terminating at a distinct corner. For lanceolate and broad-necked points, the shape of the base (concave, convex, or straight) is defined by the basal indentation ratio (BIR) (Thomas 1981:11), which is derived by dividing the length of the body of the point (measured along the long axis of the point, from the tip to the center of the base) by the overall length of the point (measured parallel to the long axis, from the tip to the most proximal point of the base). If the tip of the point is missing, BIR is estimated by reconstructing the point (and thus the original location of its tip) on the basis of the remnant blade.

For narrow-necked, non-side-notched points, the shape of the stem is diagnostic. A diverging stem is narrowest at the neck, but a non-diverging stem is not. Diverging stems are often referred to as "expanding." For non-diverging-stemmed points, the shape of the blade corner is diagnostic. A barbed point is one whose blade corner or shoulder projects downward, even if only slightly; and a shouldered point has no such downward projection at the corner of the blade. The final attribute to mention is the stem ratio (SR), which is defined as the ration of NW to BW (the SR is not listed among the attributes in Appendix D, as it used only as a distinguishing criteria between the Elko and Gatecliff series).

Type SSN (Small Side-notched) is narrow-necked and side-notched. Specimens typically have triangular blades and straight or concave bases. This type is comparable to the Desert Side-notched type common in the Great Basin.

Type UST (Unstemmed Triangular) is unstemmed and triangular, with a straight base. This type resembles the traditional Cottonwood Triangular type of the Great Basin, except that Cottonwood Triangular may have concave bases. Type UST points may simply be unnotched blanks for type SSN or other small, triangular types.

Type RGA (Rosegate A) is stemmed, not notched, narrow-necked, barbed, with a diverging stem. As mentioned above, those points with BW of 10 mm or greater, or with WT of 1.65 or greater are not grouped with narrow-necked points, and are not included in Type RGA or other narrow-necked types. Type RGA would probably be traditionally typed as Rose Spring Contracting Stem.

Type RGB (Rosegate B) is stemmed, not side-notched, narrow-necked, shouldered, with a non-diverging stem. This group would traditionally be typed in the same way as Type RGA.

Type RGC (Rosegate C) is stemmed, not side-notched, narrow-necked, with a diverging stem. Both barbed and shouldered styles are included. Corresponding traditional named types which would be included here are the Rose Spring Corner-notched, Eastgate Split Stem, and Eastgate Expanding Stem.

Type EE (Elko Eared) is stemmed, broad-necked, not side-notched, with BIR less than or equal to 0.93 (concave base), and SR less than 0.85. This group is comparable to the traditionally defined Elko Eared type.

Type ECN (Elko Corner-notched) is stemmed, broad-necked, not side-notched, with BIR greater than 0.93 (straight or convex base), and SR less than 0.85. This class would traditionally be typed as Elko Corner-notched.

Type GSS (Gatecliff Split Stem) is stemmed, broad-necked, not side-notched, with SR greater than or equal to 0.85 and BIR less than or equal to 0.97 (concave base or split stem). This type incorporates the traditional Pinto Series types.

Type GCS (Gatecliff Contracting Stem) is stemmed, broad-necked, not side-notched, with SR greater than or equal to 0.85 and BIR greater than 0.97 (straight or convex base). This group would include the traditional Gypsum type.

Type HCB (Humboldt Concave Base) is unstemmed, lanceolate, with a concave base and a narrow basal section. This type includes the traditional Humboldt Concave Base types.

Type LSN (Large Side-notched) is side notched and broad-necked. Specimens typically have lanceolate blades and concave bases, and resemble what have been termed Northern Side-notched points.

APPENDIX D

COMPLETE PROJECTILE POINT DATA

The following is a list of the attributes recorded from the projectile points collected during the cultural resource survey of the TCOCU. The individual specimens are identified in two different ways. The isolated points (those not recovered from within sites) are identified by the quadrat from which they were collected, followed a number unique to a particular specimen, assigned in the order in which they were collected in the field (such that 39-40-5-SE-1 was the first projectile point collected from quadrat 39-40-5-SE). Those projectile points collected from within sites are identified by the site number, followed by a number unique to a particular specimen, i.e., 35ML5350-1. All the measurements are in millimeters, except for weight, which is in grams. An asterisk (*) after a measurement indicates that the measurement reflects a fragmented attribute, while a dash (-) indicates a measurement that is either not applicable for that type, or was unattainable due to fragmentation. The following is a list of the abbreviations used in the column headings:

RM - Raw Material (OBS - Obsidian, CCS - cryptocrystalline silica)
NW - Neck Width
BW - Base Width
BIR - Basal Indentation Ratio
L - Length
W - Width
TH - Thickness
WT - Weight
FRAG - Fragmentation Type Code, as follows:

C - Complete point
T - Tip missing
S - Stem missing
Sb - Stem base missing
BS½ - Entire corner and half of stem missing
B - Barb missing
L - Side (lateral) missing
FM - Mid-section fragment
D - Distal impact scar

The projectile point types and acronyms have been discussed in Appendix C; the following abbreviations have been added for the purposes of the projectile point data compilation:

E/G - Indistinguishable Elko/Gatecliff
ERC - Erratic
? - Undeterminable type

SPECIMEN	TYPE	RM	NW	BW	BIR	L	W	TH	WT	FRAG
35ML5300-1	GSS	OBS	16	12*	.925	40	19	6	3.8*	B
40-38-21-NE-1	?	OBS	12	-	-	23*	25*	5	3.0*	T,B,Sb
39-39-22-NE-1	GSS	OBS	12	11*	.967	26*	17*	5	1.6*	T,L,B
40-41-7-NE-1	ERC	OBS	-	-	-	21*	13*	5	1.3*	T,B,B
39-39-13-NW-1	?	OBS	14	-	-	41*	25*	6	5.5*	T,L,B,Sb
40-40-12-NE-1	GSS	OBS	21	14*	.96*	40*	33	8	10.5*	T,L,BS½
39-40-27-NE-1	EE	OBS	11	14*	.93*	40	22*	5	2.6*	B,Sb
39-40-27-NE-2	GSS	OBS	14	16*	.94*	30*	20	6	3.0*	T,B,D
39-40-5-SE-1	ECN	OBS	14	7*	.953	30*	25	5	3.0*	T,B
39-40-5-SE-2	GSS	OBS	12	12*	.91	17*	16	4	1.1*	T,D
39-41-21-NE-1	GSS	OBS	11	9	.89	20*	14	4	0.9*	T,L,B
35ML5350-1	ECN	OBS	15	17	.98*	17*	28	4	2.2*	T
35ML5350-2	HCB	OBS	-	13	-	44	15	7	3.5*	B
35ML5350-4	RGA	CCS	7	7	-	22*	14*	5	1.4*	T,L
35ML5350-5	RG	OBS	6	-	-	20*	12*	4	0.7*	T,L,BS½
35ML5323-1	GSS	OBS	12	11*	.95*	31*	23*	6	3.9*	T,B,Sb
35MH5322-1	?	OBS	-	-	-	23*	29	4	3.2*	T,S
41-39-18-SW-1	?	OBS	14	-	-	37*	27*	5	3.6*	B,S
41-39-18-SW-2	?	OBS	-	-	-	47*	27	7	8.5*	T,B,D
41-39-18-SW-3	LSN	OBS	10	16	-	31*	16	5	1.9*	T
40-39-14-SE-1	?	OBS	-	-	-	15*	11*	3	0.4*	T,BS½
40-39-14-SE-2	RG	CCS	8	-	-	27*	18*	5	1.8*	T,BS½
40-39-14-SE-3	?	OBS	13	-	-	39*	22*	5	4.1*	T,S,B

SPECIMEN	TYPE	RM	NW	BW	BIR	L	W	TH	WT	FRAG
35ML5329-1	RGC	OBS	7	9*	-	19*	18	4	1.2*	T,Sb,D
35ML5329-2	HCB	OBS	-	14	-	36*	16	4	2.9*	B
35ML5326-1	ELKO	OBS	11	-	-	30	18*	6	2.9*	T,BS½
40-40-25-SE-1	GCS	OBS	12	11*	.94	33	21*	6	3.2*	B,B,D
40-40-25-SE-2	ERC	OBS	-	-	-	48*	30*	8	9.9*	B,L
35MH5323-2	?	OBS	-	-	-	25*	16*	4	1.6*	T,B
40-40-25-SE-4	ELKO	OBS	8	8*	-	27*	23	6	3.0*	T,Sb
40-40-25-SE-3	E/G	OBS	13	-	-	29*	22	5	3.1*	T,Sb
35ML5316-1	GCS	OBS	16	13*	-	26*	24*	5	3.5*	T,L,B
35ML5316-2	GSS	OBS	17	19	-	32*	22*	6	3.9*	T,B
35ML5316-3	RG	OBS	8	-	-	18*	13	4	0.9*	T,S
35ML5316-4	ECN	OBS	13	15	.974	35*	25*	5	3.9*	T,B
35ML5316-5	?	OBS	-	-	-	23*	22*	5	2.9*	T,BS½
41-39-5-SE-1	LSN	OBS	11	21	.98*	33*	21*	6	4.1*	T,L
41-39-5-SE-2	?	OBS	-	14	-	34*	24*	5	3.6*	T,B
35MH5348-1	EE	OBS	14	17	.93*	38*	24	6	4.1*	T,B
38-40-19-NW-1	ELKO	OBS	10	-	-	26*	27*	5	2.0*	T,B,Sb
38-40-19-NW-2	SSN	OBS	8	15	.91*	26*	15	3	0.9*	T
38-40-19-NW-3	E/G	OBS	11	-	-	24*	21*	5	2.6*	T,B,Sb
38-40-20-SW-1	E/G	OBS	13	-	-	23*	25*	5	2.8*	T,B,Sb,D
38-40-20-SW-2	HCB	OBS	-	18	-	37*	18	6	3.2*	T,B
38-40-1-NW-1	UST	CCS	-	13	.96	24	13	3	0.8*	B
39-39-9-SW-1	E/G	OBS	11*	-	-	20*	21*	5	1.9*	T,Sb,B

SPECIMEN	TYPE	RM	NW	BW	BIR	L	W	TH	WT	FRAG
39-39-9-SW-2	ECN	OBS	14	15	.97*	24*	19	5	2.1*	T,D
39-39-9-SW-3	HCB	OBS	-	15	-	29*	21*	7	4.0*	T
39-39-9-SW-4	GSS	OBS	19	16	.89	25*	31*	5*	2.7*	T
35ML5360-1	GSS	OBS	19	16	.87	49*	33	7	7.9*	T,BS½,D
35ML5360-2	HCB	OBS	-	10	-	22*	15*	5	1.7*	T
40-38-1-NE-1	RGC	OBS	6	6*	-	32*	14	5	1.8*	T,Sb
40-38-1-NE-2	HCB	OBS	-	13	-	18*	19*	4*	1.2*	T
35ML5359-1	RGC	OBS	7	-	-	17*	17*	4	1.0*	T,Sb,B
37-37-14-SE-1	?	OBS	-	-	-	25*	17*	6	2.2*	FM,D
37-37-14-SE-2	HCB	OBS	-	10	-	28*	16	6	2.6*	T,D
37-37-14-SE-3	EE	OBS	10	11	.93	27	21*	5	1.8*	B
37-37-14-SE-4	E/G	OBS	11	-	-	21*	15*	4	1.2*	T,L,BS½
37-37-14-SE-5	GCS	OBS	14	-	-	29*	21*	5	2.3*	Sb,B
35ML5357-1	HCB	OBS	-	12	-	12*	17*	6	1.2*	T
35HA5105-1	LSN	OBS	10	18	.90	29*	18	3	1.5*	T
35HA5105-2	ECN	OBS	10	10*	.97	32	17	5	2.1*	L,B
35HA5105-3	HCB	OBS	-	14	.94	31	15	5	1.8	C
35HA5103-1	?	OBS	-	-	-	34*	20*	4	3.1*	T,S,L
39-38-24-NE-1	EE	OBS	12	-	-	29*	20*	6	2.5*	Sb,BS½
39-39-5-NW-1	GSS	OBS	20	16	.88	24*	32*	5	4.0*	T,S,B,D
39-39-5-NW-2	GCS	OBS	12	11*	1.0	29*	24	6	4.2*	T,D
39-39-5-SW-1	SSN	CCS	8	9	.96	19*	10	4	0.5*	T

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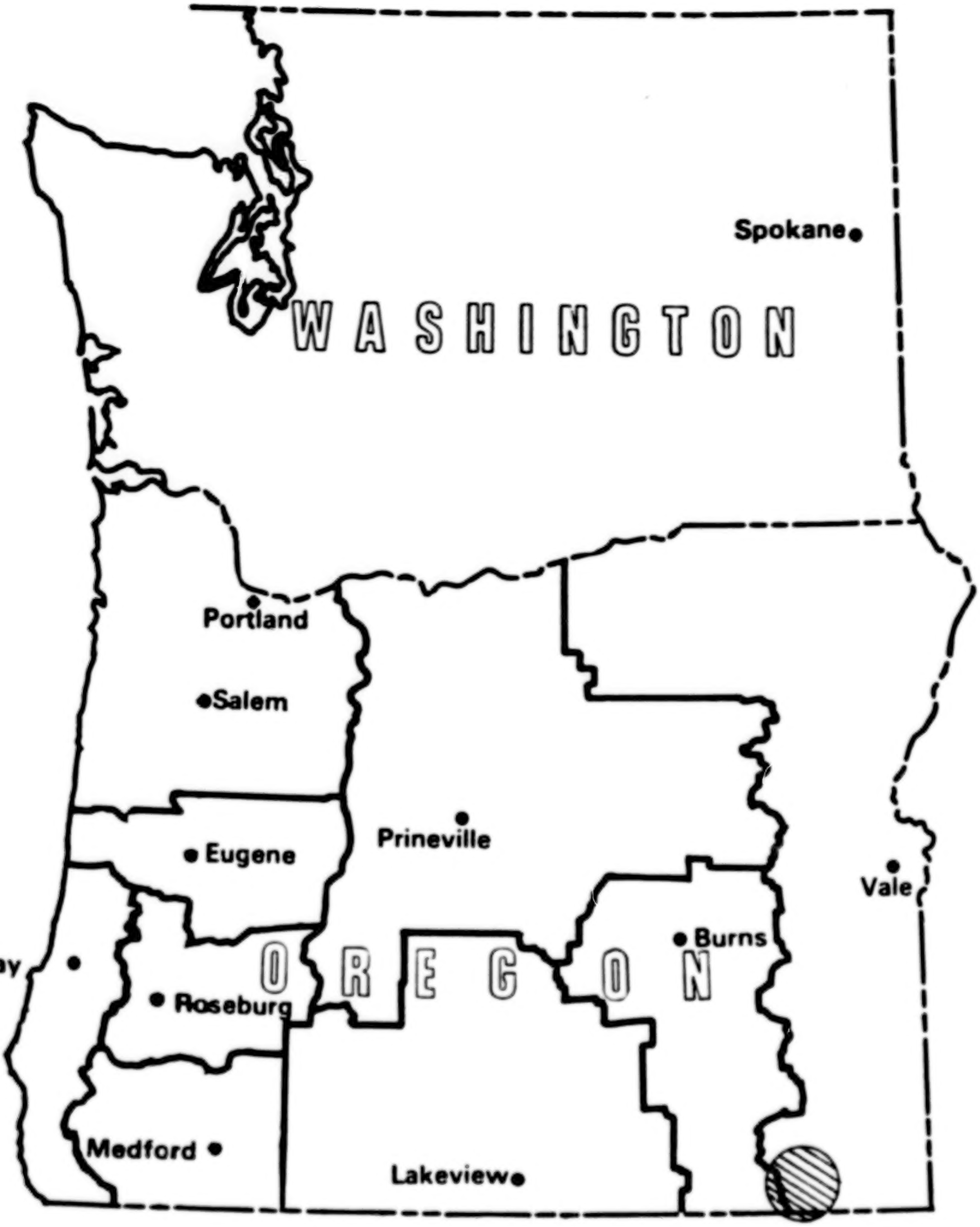
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